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Clivia mirabilis (Amaryllidaceae: Haemantheae) a new species from Northern Cape, South Africa

J.P. ROURKE*

Keywords: Amaryllidaceae, arid Mediterranean climate, *Clivia* Lindl., new species, Northern Cape

ABSTRACT

Clivia **mirabilis** Rourke is a new pendulous tubular-flowered species from Oorlogskloof Nature Reserve in Northern Cape. Its distribution area is some 800 km outside the previously accepted range of the genus *Clivia*. This sun-tolerant species is adapted to an arid Mediterranean climate, producing vegetative growth in winter and maturing its seeds rapidly in late summer/early autumn to synchronize with the arrival of winter rains.

INTRODUCTION

The genus *Clivia* Lindl., consisting of four currently recognized species, *C. nobilis* Lindl. (1828), *C. miniata* (Lindl.) Regel, *C. gardenii* Hook. (1856) and *C. caulescens* R.A.Dyer (1943), is presently considered to be endemic to southern Africa (Vorster & Smith 1994; Snijman 2000). These species occur in coastal and inland Afromontane forest from Eastern Cape through KwaZulu-Natal, Swaziland and Mpumalanga to the Soutpansberg in Northern Province. Rumours of the occurrence of *Clivia* in Mozambique have not yet been confirmed by accurately localized herbarium collections.

Clivia is an evergreen, rhizomatous genus in the Amaryllidaceae, characterized by distichous strap-shaped leaves, umbellate solid scapes and red subglobose berries containing one to few cartilaginous, pearly-white seeds embedded in soft yellow pulp.

In February 2001 material of a further species was submitted to the Compton Herbarium for identification in a batch of herbarium specimens from the Oorlogskloof Nature Reserve near Nieuwoudtville, in Northern Cape, collected by the nature conservation officer in charge, Mr Wessel Pretorius. The author confirmed this astonishing discovery during a site visit to Oorlogskloof on 22 February 2001 when two fruiting populations were examined. The new species is here described as *Clivia mirabilis*. Rarely can such an extravagant epithet as *mirabilis* be confidently applied, yet in the case of this extraordinary *Clivia*, so unusual in its distribution and characters, its usage seems entirely appropriate.

Clivia mirabilis *Rourke*, sp. nov., a speciebus affinibus, corollis actinomorphis rectis tubularibus bicoloribus (miniatis/luteis); pedicellis cernuis, 22–40 mm longis, miniatis per anthesin (demum viridibus post anthesin); foliis lineamentis medianis albis et apicibus acutis, distinguitur.

Rhizoma perenne solitarium, erectum; caespite foliorum 0.6–1.2 m alto. *Folia* disticha, rigida, erecta, 0.6–1.2 m longa, 30–50 mm lata, glabra, coriacea, lineamentis medianis albis; margines cartilagineae, plerumque laeves, interdum leviter scabra; apices acuti. *Scapus* 300–800 mm longus, carmineus, late ancipitius. *Inflorescentia* umbellata, 20–48 floribus; spathae 5–7, cymbiformi-acutae, papyraceae, 35–50 mm longae, 10–15 mm latae. *Pedicelli* cernui, graciles, 25–40 mm longi, miniati per anthesin, abrupte viridescentes post anthesin. *Perianthium* rectum, tubulosum, 35–50 mm longum, dilatatum versus orem; miniatum sed viride ad apicem per anthesin, tandem flavescens distale. *Antherae* 6, basifixae, leviter exsertae; filamenta 30 mm longa, basaliter adpressa circa stylum. *Stylus* 40–45 mm longus, trilobatus; apices subtiliter penicillati. *Ovarium* ovoideum, nitidum, miniatum per anthesin; viride post anthesin; loculi 3–4-ovulati. *Baccae* pendentes, irregulariter ovoideae, glebulosae; (1)2–5(–7) semina continentes, pericarpium maturum scarlatinum. *Semina* irregulariter ovoidea, ± 10 mm in diam., alba.

TYPE.—Northern Cape, 3119 (Calvinia): Nieuwoudtville, Oorlogskloof Nature Reserve, eastern margin of Oorlogskloof Canyon at Agterstevlei Farm, (–AC), ± 900 m, 18-10-2001, *J.P. Rourke 2220* (NBG, holo.; BOL, K, MO, NSW, PRE, iso.).

Stout, rhizomatous, solitary, evergreen perennial, 0.6–1.2 m tall; stem reduced to a vertical rhizome, up to 250 mm long terminating in a tuft of leaves. *Root system* massive, up to 0.7 m diam., horizontally spreading; roots perennial, very stout, fleshy, up to 20 mm diam., outer surface covered in a corky, velamen-like layer. *Leaf sheath* prominent, flushed deep carmine (RHS 183A greyed-purple). *Leaves* long-lived, stiffly erect, distichous, strap-shaped, 0.6–1.2 m long, 30–50 mm wide, flattened to slightly V-shaped with a distinct pale whitish grey striation in the midrib area on upper surface, striation becoming less distinct in older leaves, coriaceous, glabrous, deep dull green, flushed carmine-maroon at base, apex obtuse-acute; margins entire, cartilaginous, usually smooth, occasionally irregularly scabrous, becoming slightly revolute in old, mature leaves. *Scape*

*Compton Herbarium, National Botanical Institute, Private Bag X7, 7735 Claremont.
MS. received: 2002-01-25.


A
B
C
D
E
F

300–800 mm long, broadly ancipitous, longitudinally ridged, 10–14 mm wide, glabrous, carmine-flushed. *Inflorescence* umbel-like, 20–48-flowered, subtended by 5–7 brownish/carmine, papyraceous spathe valves, narrowly cymbiform-acute, 35–50 × 10–15 mm; pedicels drooping, slender, 25–40 × 1.2 mm, orange-red, abruptly turning green in post-pollination phase. *Perianth* straight to imperceptibly curved, tubular, becoming progressively flared towards apex, 35–50 × 5 mm below ovary, 10–12 mm diam. at mouth, orange-red (RHS 32B) proximally, green-tipped (RHS 145A) distally on opening, the green changing to yellow (RHS 22B) distally, entire perianth becoming deep orange-red (RHS 33A) after anthesis; tepals fused distally to form a tube 10–15 mm long, outer tepals narrowly oblong, apices acute, inner tepals slightly wider, apices obtuse, outwardly flared. *Stamens* 6, dorsifixed, 2 mm long, very slightly exserted at anthesis; filaments 30 mm long, attached to tepals 10 mm above ovary; inwardly bowed proximally, adpressed around style at point of attachment forming a 10 mm long nectar well above ovary. *Ovary* ovoid, shiny, greenish yellow in bud, becoming orange-red at anthesis, changing to bright green in post-pollination phase; ovules 3 or 4 in each locule; style 40–45 mm long, terete, glabrous, tapering distally, included at anthesis, later elongating and becoming exserted 5–8 mm in post-pollination phase; stigma trilobed, lobes 0.4–1.0 mm long, penicillate at apex. *Fruiting heads* with 25–35 pendent berries. *Berries* irregularly oblong to ovoid, 10–30 × 10–15 mm, glebulose to submoniliform, often narrowed to a distinct neck above pedicel, apex often tapering to an eccentrically angled beak, containing (1)2–4(–7) gongyloid seeds projecting prominently and irregularly through thin pericarp; pericarp glossy, pale apple green, maturing through yellow, orange to pinkish red; mature berries red (RHS 40B eventually becoming RHS 45B). *Seeds* somewhat ovoid, slightly faceted, ± 10 mm diam., pearly white; embryo green. (Colour references according to Royal Horticultural Society colour chart.) Figure 1; Plates 1 & 2.

Diagnostic characters

Clivia mirabilis is distinguished by its straight, actinomorphic, bicolored (orange/yellow) tubular corolla, long drooping pedicels, 25–40 mm long, that are orange-red at anthesis and green when fruiting; the distinctive single median white striation on the upper surface of the leaves with smooth cartilaginous margins; and irregularly shaped glebulose-gongyloid berries. The basal part of the leaves forming the leaf sheath is flushed a deep carmine maroon, unlike any other *Clivia* except *C. nobilis*, which occasionally produces similarly coloured leaf bases. The orange-red coloration of the pedicels in this species during anthesis is a unique character in the genus *Clivia*.

Distribution and habitat

Apparently confined to the Oorlogskloof Nature Reserve in Northern Cape (Figure 2), *Clivia mirabilis* is restricted to a small area on the eastern margin of the Oorlogskloof Canyon. Populations are known to occur just north of Eland se Kliphuis adjacent to Agterstevlei Farm and a little further south around the Driefontein Waterfall. The distance between these sites is ± 5 km. The species also occurs at a few sites between these two localities.

The margins of the Oorlogskloof Canyon are capped with 30 m cliffs of Peninsula Formation Sandstone. This has eroded to form coarse sandstone talus screes below the cliffs that are partly covered in a light woodland of relictual Afromontane evergreen forest elements, principally *Olea europaea* subsp. *africana*, *Maytenus acuminata, M. oleoides, Cassine schinoides, Halleria lucida* and *Podocarpus elongatus* with additional shade provided by outsize, (4 m tall) specimens of *Phylica oleaefolia*. Small groups of *C. mirabilis* grow rooted in humus between cracks in the sandstone talus of the rock scree, either as solitary individuals or in small groups. Occasionally some clumps occur in full sun but these tend to have shorter leaves and often show signs of water stress (dried leaf tips). However, the remaining leaves show no signs of sunburn, despite the intense insolation experienced for several months each year. The main population extends over several hectares and probably consists of well over 1 000 individuals. Due to the position of these two sites under the eastern cliffs of Oorlogskloof Canyon, most plants experience shade until about mid-morning after which they are in direct sun.

The area is characterized by a semi-arid Mediterranean climate with a strictly winter rainfall regime—exactly the opposite climatic conditions experienced by the other four species in this genus. The mean annual rainfall for Oorlogskloof is 414 mm, falling mainly between May and September. Vegetative growth is thus restricted to a brief winter growing period. Situated at 850–900 m, some 100 km inland from the coast, these populations are subject to brief but light frost in winter.

MORPHOLOGY AND BIOLOGY

Root system

On excavating several plants in the habitat for cultivation at Kirstenbosch, the enormous root system characteristic of this species was revealed. Large adult plants have a mass of fleshy, succulent roots radiating between $^{1}/_{2}$–$^{3}/_{4}$ m from the base of the rhizome, each root ± 20 mm in diameter. This disproportionally large volume of sub-

PLATE 1.—*Clivia mirabilis*. A, inflorescence in habitat showing orange/red pedicels; B, plants in habitat between Peninsula Formation Sandstone boulders; C, leaves showing prominent median white stripe on upper surface and variation in dimensions. D, E, fruiting head: D, immature berries; E, mature berries. F, seedlings five months after germination, note large radicle and prominent carmine pigmentation on cotyledon and at base of first pair of leaves. Photos: C. Paterson-Jones.

FIGURE 1.—*Clivia mirabilis*: A, mature inflorescence; B, fruiting head with irregularly shaped berries; C, longitudinal section through flower; note filament bases adpressed to style forming nectar reservoir; D, detail of filament bases. Scale bars: 10 mm. Artist: John Manning.

terranean biomass gives mature plants an extensive water storage capacity, allowing them to survive the prolonged rainless summers of the Oorlogskloof environment.

Flower colour, development and pollination

The general impression of a fully open scape is of bicoloured perianths, orange-red at the base, yellow towards the mouth and with orange-red pedicels. During the development of the flower, both perianth and ovary progress through a series of well-marked colour changes. The unopened bud is yellowish, but prominently green-tipped, and the ovary is also pale green. At anthesis the green coloration slowly disappears from the tips of the tepals which take on the same yellow tones as the basal half of the perianth. The pedicels and upper half of the perianth are deep orange-red at this stage. After pollination the yellow coloration disappears and the whole perianth and ovary take on a uniform orange/red colour. As the perianth begins to wither, the ovary swells and undergoes an abrupt colour change from orange to bright green, as do the pedicels. No other *Clivia* has pedicels the same colour as the perianth when the flower is fully open. The pedicels abruptly change to green as the perianth abscisses and the ovary swells in the post-pollination phase.

The purpose of these colour changes is not yet understood, but is probably related to pollinator cues. Pollination appears to be by sunbirds. A single sighting of a malachite sunbird probing the perianths was made at Oorlogskloof on 18 October 2001 suggesting that sunbirds could be involved in pollen transfer. However, like the other three tubular-flowered species, *C. mirabilis* may also be a selfer as between 80 and 90% of the flowers in each umbel are pollinated and produce viable berries. *Flowering time*: ± six weeks, from October to mid-November.

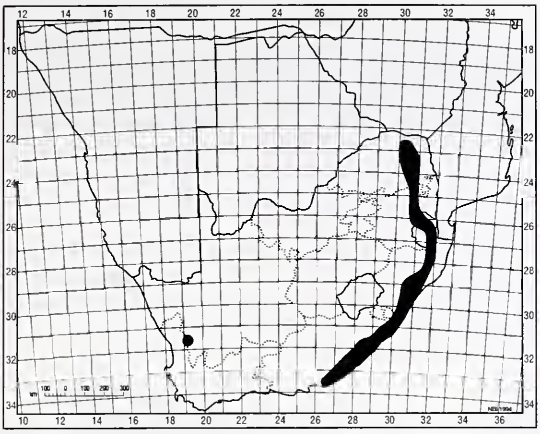

FIGURE 2.—Distribution of *C. mirabilis*, ●, in relation to the distribution of the remainder of the genus *Clivia* (black shaded area).

Fruiting

The berries mature more rapidly than in the other *Clivia* species. By the end of February, four months after flowering, the fully developed berries turn from yellow and orange to pinkish and later red by the end of March and are shed shortly thereafter prior to the onset of the first winter rains in April/May. This rapid autumn maturation of berries is in sharp contrast to the summer rainfall area clivias which mature slowly, usually 12 months for *C. miniata* and *C. gardenii,* about nine months for *C. caulescens* and *C. nobilis* (Duncan 1999) to coincide with the commencement of October/November summer rains.

Seed dispersal and germination

Berries commence falling from late February to early April. Germination appears to be rapid in response to the onset of autumn/early winter rains. At Kirstenbosch seeds sowed on 18 March 2001 had already developed a 10 mm radicle by 10 April 2001.

On germinating, the primary root develops into a swollen, white, succulent cylinder up to 50 × 5–6 mm. During the moist winter months (May–September), it swells, accumulating water in its succulent tissue. By October, two short (5–10 mm long) leaves have been produced, whereafter further vegetative growth of the seedling slows or largely ceases with the onset of summer dormancy (November–April). During the rainless phase of ± six months the seedling survives on water reserves stored in the greatly enlarged primary root. Vegetative growth commences again in autumn. Thus the biology of a *C. mirabilis* seedling in its first year is much akin to a winter rainfall area geophyte with the swollen primary root being functionally equivalent to a corm or bulb.

The phenology of the germinating seed described above is clearly an adaptation to a semi-arid Mediterranean climatic regime—exactly the reverse of the summer rainfall region *Clivia* species.

Within a few months of germinating, the plumular bud (cotyledon plus first true leaf) (Boyd 1932), becomes densely pigmented with anthocyanins (Plate 1F). This prominent development of anthocyanins at the base of the leaves is later evident in the leaf sheaths of adult plants which are heavily suffused with purple-carmine pigments. Why the seedlings of *C. mirabilis* are so densely pigmented with anthocyanins is not clear, but it may be a response to the intense levels of sunlight experienced in the natural habitat, thereby providing effective screening during the seedlings' critical establishment phase.

Relationships

The distribution ranges of all four previously known *Clivia* species are contiguous or overlap, while at many localities different pairs of species occur sympatrically, *C. nobilis* with *C. miniata*, *C. gardenii* with *C. miniata*, and *C. caulescens* with *C. miniata*. Geographically, populations of *C. nobilis* in Eastern Cape, though more than 800 km distant, are the closest spatially to *C. mirabilis. C. nobilis* also appears to be the closest relative to *C. mirabilis* on morphological grounds: tough stiffly erect coriaceous leaves with a median pale striation on the upper surface (some populations of *C. nobilis* occasionally have a faint median striation), and the small seeds.

Phytogeographic implications

Palynological evidence indicates that in Western Cape and southern Namaqualand, subtropical forests were present during Miocene and Pliocene times (± 5.3 million years BP) (Scott *et al.* 1997). Since then, apart from more recent cyclical changes in the Quaternary, there has been a progressive eastward retreat of these forest elements. Assuming that the genus *Clivia* has not changed its dependence on a forest environment significantly since pre-Quaternary times, it can be argued that the Nieuwoudtville species is relictual and that its survival in the Oorlogskloof Canyon is partly fortuitous and partly due to its adaptation to a different climate. The berry maturation period, seedling and germination biology are so perfectly in harmony with an arid Mediterranean climatic regime that *Clivia mirabilis* is able to survive environmental conditions inimical to all other *Clivia* species.

It is currently believed that the late Miocene also saw the development of a Mediterranean climate in the western part of the Cape (Axelrod & Raven 1978). This would have interrupted the further spread of an essentially summer rainfall genus like *Clivia* into the forests of the southern and western part of the Cape. It would also have left the precursors of *Clivia mirabilis* to adapt to increasing aridification and the onset of a pronounced Mediterranean type climate. Thus if *C. mirabilis* evolved from forms with an essentially summer rainfall phenology, the adaptation to an arid Mediterranean type climate is a derived condition dating from late Miocene times.

Long distance dispersal should also be considered as a possible explanation for this bizarre distribution pattern, but this seems highly unlikely as no living vectors

for the long-distance dispersal of *Clivia* seed have yet been identified nor has biotic dispersal been recorded for any other species of Amaryllidaceae (Meerow & Snijman 1998). Birds are probably the main seed dispersal vectors. *Clivia miniata, C. gardenii* and *C. caulescens* have all been observed by the author growing epiphytically in forest trees, five or more metres above ground level. It is probable that frugivorous birds deposited seeds in these positions, leading one to postulate that forest dwelling birds are responsible for the dispersal of large scarlet *Clivia* berries. While the dispersal of *Clivia* seed by birds between closely adjacent forest patches is a strong possibility, dispersal over distances of 800 km of arid country seems highly unlikely.

Conservation status

No populations are known outside the Oorlogskloof Nature Reserve where the species currently enjoys maximum protection. Yet there is no reason why *C. mirabilis* should not occur further down the Oorlogskloof Canyon, outside the reserve, as numerous suitable habitats occur there. If this proves to be the case, special efforts will have to be made to protect these populations as the species' horticultural potential will render it vulnerable to exploitation.

Other material examined

NORTHERN CAPE.—3119 (Calvinia): Oorlogskloof Nature Reserve, (–AC), 10-11-2000, *W. Pretorius 651* (NBG).

ACKNOWLEDGEMENTS

I am most grateful to the Northern Cape Department of Nature and Environmental Conservation for granting permission to collect the type material of this species; also to Wessel Pretorius, officer in charge of the Oorlogskloof Nature Reserve for his generous assistance in the field. Colin Paterson Jones patiently photographed various stages in the life history of *C. mirabilis* and John Manning skilfully prepared the line drawings reproduced here. Dee Snijman and John Manning provided critical comments on early drafts of the manuscript. I thank all of them for their invaluable assistance.

Auriol Batten's fine painting of *C. mirabilis* was prepared from the type material. I am especially grateful to her for loaning this plate to the National Botanical Institute for reproduction in this paper.

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PLATE 2.—*Clivia mirabilis*, × 0.75, showing flowering and fruiting scapes against a background depicting Oorlogskloof Canyon. A fully open inflorescence on left shows the red/yellow colour pattern. A younger inflorescence with green tipped perianths is on its right. From the type collection, *Rourke 2220*. Artist: Auriol Batten.


Auriol Batten

Bothalia 32,1: 9–13 (2002)

The genus *Buglossoides* (Boraginaceae) in southern Africa

E. RETIEF* and A.E. VAN WYK**

Keywords: Boraginaceae, Boraginoideae, *Buglossoides* Moench, Lithospermeae, nutlets, pollen, southern Africa, taxonomy

ABSTRACT

The genus *Buglossoides* Moench, a member of the family Boraginaceae, subfamily Boraginoideae, tribe Lithospermeae, is revised for the *Flora of southern Africa (FSA)* region. *Buglossoides* comprises about seven species of annual, biennial or perennial herbs and subshrubs native to Asia, southern Europe and northern Africa. *B. arvensis* (L.) I.M.Johnst., a naturalized weed in many parts of the world, is the only member of the genus represented in the flora of southern Africa, presumably introduced with imported cereal seed. Although the similar polyaperturate pollen grains of *Buglossoides* and *Lithospermum* support the view that they are congeneric, they are retained as separate entities here. Diagnostic characters, a full description, various illustrations and a distribution map of *B. arvensis* in southern Africa are given.

INTRODUCTION

In 1794 Moench established the genus *Buglossoides* (Boraginaceae/Boraginoideae/Lithospermeae), separating it from the closely related genus *Lithospermum* L. Ever since, the generic status of *Buglossoides* has been a matter of controversy. De Candolle (1846), Boissier (1879), Gürke (1897), Wright (1904), Riedl (1967) and Mabberley (1997) regarded the genus as congeneric with *Lithospermum*, not accepting or unaware of Moench's view. In 1954 Johnston published a taxonomic revision of *Buglossoides*. He used the corolla throat, decorated inside with five well-developed vertical lines of hairs, to distinguish *Buglossoides* from *Lithospermum*, which is characterized by a corolla throat lacking these hairs but bearing localized faucal appendages or groups of stipitate glands. *Buglossoides* was accepted by various authors like Ingram (1958), Fernandes (1972), Edmondson (1978), Qaiser (1979), Brummitt (1992), Al-Shehbaz (1991), Verdcourt (1991), Herman (1993), Retief & Herman (1997), Lebrun & Stork (1997) and Retief (2000), and this view is also taken here.

Buglossoides is a genus of about seven species, distributed primarily in the European portion of the Mediterranean region and in adjacent southeastern Asia, with a single species indigenous to China, Korea and Japan (Al-Shehbaz 1991). *B. arvensis* (L.) I.M.Johnst. is the only member of the genus represented in the flora of southern Africa, scattered across the region. *B. arvensis* most probably reached southern Africa with imported cereal seed. It is widespread as a naturalized weed in many parts of the world. As yet it is not known from the *Flora zambesiaca* region, but is recorded in Tanzania and North Africa. Fernandes (1971, 1972) reduced three *Buglossoides* species to subspecies of *B. arvensis*. However, typically *B. arvensis* differs from these taxa in its infundibuliform corolla (not hypocrateriform), a calyx that usually equals or exceeds the corolla tube in flower (not with calyx distinctly shorter) and in its distribution (not confined to the Mediterranean region). It is here recognized as a separate species. One of the three species concerned, *B. sibthorpianum* Griseb., is regarded as conspecific with *B. arvensis* by Edmondson (1978) and Qaiser (1979).

De Candolle (1846) already cited *Burchell 1686* under *Lithospermum arvense* L. Burchell collected his specimen at Kloof village in the Asbestos Mountains, Northern Cape in 1811. Wright (1904) in his revision of *Lithospermum* in *Flora capensis* cited several localities in South Africa where '*L. arvense*' had been collected. Bolus & Wolley-Dod (1904) also mentioned the occurrence of *Buglossoides arvensis* because Wolley-Dod had collected it at a few places on the Cape Peninsula. Although Wright (1904) and Ross (1972) cited *Gerrard 230* for KwaZulu-Natal, *B. arvensis* is not recently recorded from the region.

In this paper, diagnostic characters, a full description, various illustrations and a distribution map of *Buglossoides arvensis* in southern Africa are given. The description is based exclusively on local collections. This paper forms part of a revision of the Boraginaceae for the *Flora of southern Africa* (*FSA*) which is currently in progress.

MATERIALS AND METHODS

Herbarium specimens of *Buglossoides arvensis* housed in BM, BOL, E, GRA, K, NBG, NH, NMB, NU, PRE, PRU and SAM were studied to assess morphological variation as well as phenological and distributional attributes. Acetolysis of pollen followed the standard method of Erdtman (1960). For scanning electron microscope studies, samples were coated with gold and studied with an ISI-SX-25 SEM. Measurements of pollen grains were taken with the light microscope from acetolysed grains mounted in glycerine jelly.

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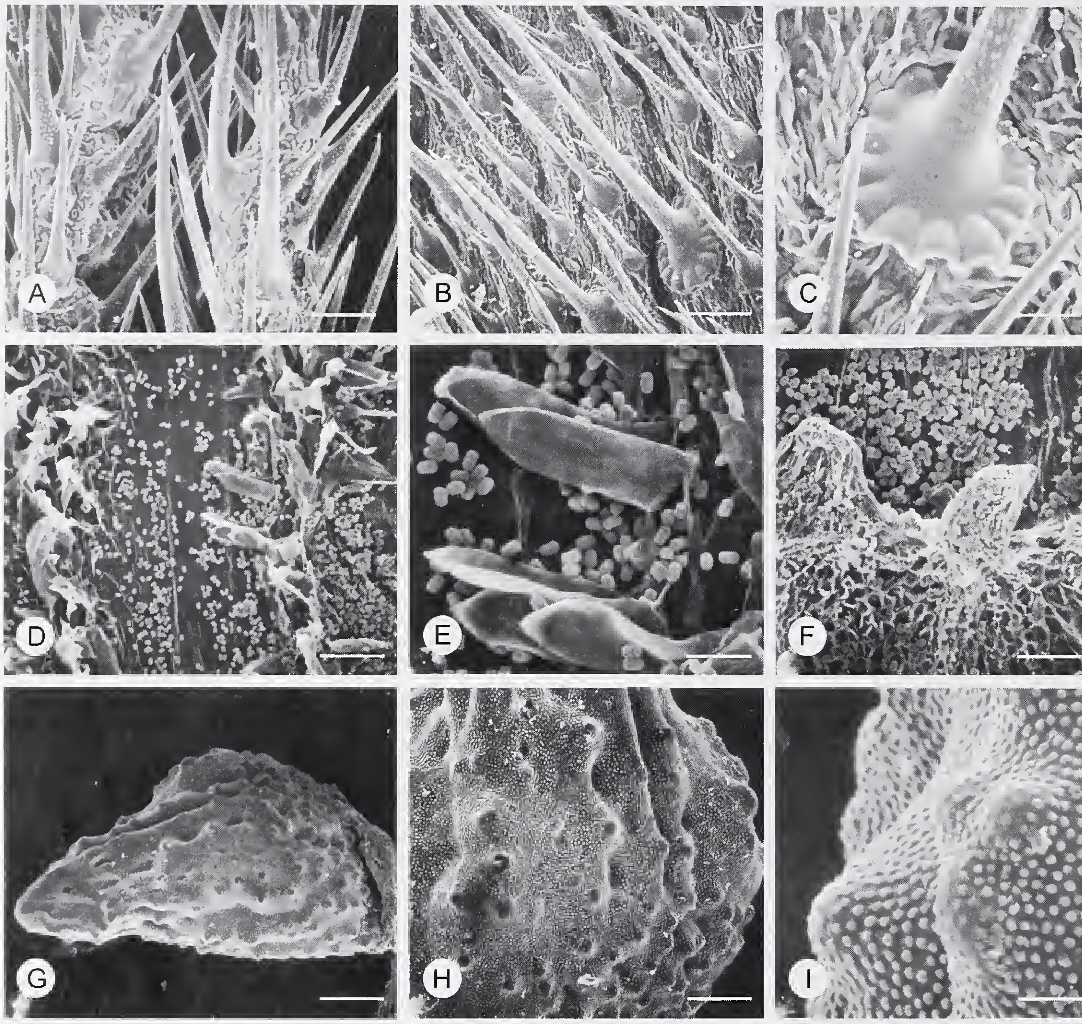

FIGURE 1.—*Buglossoides arvensis*. A–C, rigid setae: A, on calyx lobes; B, on upper leaf surface; C, basal part. D, E: inner corolla; D, lines of hairs; E, close up of hairs and pollen grains. F, part of annulus and pollen grains; G, nutlet; H, I, rugose, tuberculate nutlet surface. A–E, H, I, *Acocks 17740*; F, *Acocks 19035*; G, *Acocks 17805*. Scale bars: 10 mm. A, 122 µm; B, 190 µm; C, 492 µm; D, 130 µm; E, 36 µm; F, 71 µm; G, 528 µm; H. 269 µm; I, 59 µm.

MORPHOLOGICAL CHARACTERS OF TAXONOMIC SIGNIFICANCE

Macromorphology

Species of *Buglossoides* are divided into two groups: perennials with corollas 12–20 mm long, nutlets smooth or punctate-reticulate, white or yellowish and shiny, and annuals with corollas up to 10 mm long, nutlets tuberculate, brownish or greyish and not shiny. *B. arvensis* belongs to the latter group. The species is distinguished from others in the genus by its calyx with a whitish indumentum and by the calyx lobes which are strongly accrescent in fruit, narrow, acute and covered with long, rigid setae (Figure 1A) and hairs (Leistner 2000: 759). The indumentum of the leaves is appressed-setulose with rigid setae, and the multicellular bases of the setae are 1-layered (Figure 1B, C). *B. arvensis* is distinguished from all species of *Lithospermum*, and from all other southern African representatives of Boraginaceae, by a combination of the following characters: five longitudinal bands of hairs extending from the base of the corolla lobe downwards to the tips of the anthers, as is typical for the genus (Figure 1D, E); an annulus of scale-like lobes present near the base of the corolla tube (Figure 1F); and nutlets that are rugose and tuberculate (Figure 1G–I).

Pollen

Pollen of *Buglossoides arvensis* is isopolar and prolate, with P = 12.5–18.8 µm and E = 8.3–12.6 µm. In equatorial view, the grains are rectangular to elliptic, with the long sides more or less straight and the poles convex, but frequently collapsing inwards (Figure 2A, B). Ectoapertures are positioned at the equator, rhombic in outline, regularly granular and the margins are not thickened. Endoapertures are situated on or near the equator and are ± oval and lalongate. The tectum is psilate. Orbicules are present.

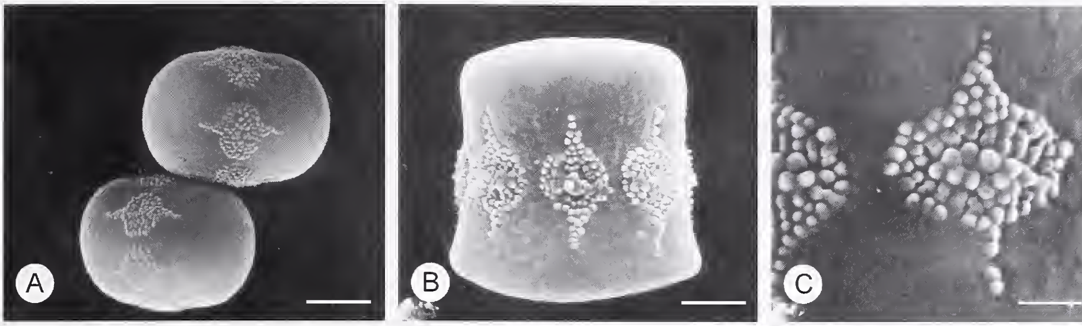

FIGURE 2.—*Buglossoides arvensis*. A, pollen grains; B, pollen grain with collapsed poles; C, granular aperture and psilate tectum. All grains acetolysed. A, *Acocks 17805*; B, C, *Acocks 17740*. Scale bars: 10 mm. A, 4 μm; B, 2 μm; C, 1 μm.

The polyaperturate pollen grains of *Buglossoides*, similar to those of *Lithospermum*, support the merging of these genera. In their studies on pollen, Clarke (1977) and Diéz *et al.* (1986) accepted *Buglossoides* as a separate genus. Ahn & Lee (1986), in a palynotaxonomical study of the Korean Boraginaceae, did not accept *Buglossoides*. Johnston (1954) divided the genus into two sections and concluded that the pollen of section *Eubuglossoides* (e.g. *B. arvensis*) is isopolar, whereas pollen of section *Margarospermum* (e.g. *B. purpurocaerulea* (L.) I.M.Johnst.) is heteropolar and shows similarity to pollen of *Lithospermum*. Pollen morphology thus suggests that whereas the section *Margarospermum* can perhaps be included in *Lithospermum*, members of the section *Eubuglossoides* are from *Lithospermum* and best retained in *Buglossoides*. The white, smooth, shiny nutlets of *Buglossoides purpurocaerulea* similar to those of *Lithospermum afromontanum* Weim., for example, as opposed to the rugose, tuberculate ones of *B. arvensis*, support Ahn & Lee's (1986) view. Heterostyly is absent in *B. arvensis* and a vast amount of pollen is released on to the corolla and between the lines of hairs (Figure 1D–F).

Pollen of southern African Boraginaceae is classified into seven pollen types (Retief & Van Wyk 1999). Two genera *Lobostemon* and *Echiostachys*, mainly confined to Western Cape of South Africa, and the two species of *Echium* introduced into southern Africa, are often regarded as belonging to the tribe Lithospermeae in the subfamily Boraginoideae (Johnston 1954). The triaperturate, heterocolpate pollen grains with a reticulate tectum found in these genera are very different from those of *Buglossoides* and *Lithospermum*, which are polyaperturate with a psilate tectum. Palynology supports the recognition of a separate tribe, Echieae, for *Lobostemon*, *Echiostachys* and *Echium*.

Buglossoides *Moench*, Methodus plantas horti botanici et agri marburgensis: 418 (1794); R.Fern.: 87 (1972); Al-Shehbaz: 129 (1991); Verdc.: 79 (1991); Retief: 180 (2000). Type: *B. tenuiflora* (L.f.) I.M.Johnst.

Lithospermum L.: 132 (1753), pro parte.

The genus name is derived from *Buglossum* Miller, the name of a genus now reduced to a section of *Anchusa* L., and *eidos* = appearance, alluding to the superficial resemblance of the two genera; the name *Buglossum* is derived from the Greek *bous*, an ox and *glossa*, a tongue, in reference to the broad, rough leaves (Al-Shehbaz 1991).

Buglossoides arvensis *(L.) I.M.Johnst.* in Journal of the Arnold Arboretum 35: 42 (1954); Edmondson: 316 (1978); Qaiser: 82 (1979); Meikle: 1148 (1985); Tölken: 1152 (1986); Verdc.: 79 (1991); Gibbons & Brough: 204 (1992); Retief & Herman: 350 (1997). *B. arvensis* (L.) I.M.Johnst. subsp. *arvensis* sensu R.Fern.: 87 (1972). Type: Europe, *Herb. Linn. 181/4* (LINN, syn.–PRE, microfiche!).

Lithospermum arvense L.: 132 (1753); A.DC: 74 (1846); Boiss.: 216 (1879); C.H.Wright: 24 (1904); I.M.Johnst.: 7 (1927); Levyns: 688 (1950); Levyns: 234 (1966); Jacot Guill.: 235 (1971); J.H.Ross: 298 (1972).

Illustrations: Qaiser: 83 (1979); Tölken: 1153 (1986); Verdcourt: 80 (1991); Gibbons & Brough: 205 (1992).

Annual herb up to 0.6 m high, greyish green, hispidulous-strigillose. *Roots* purplish red. *Stems* erect or decumbent, densely covered with appressed setae, 0.7–1.0 mm long. *Leaves* sessile, narrowly ovate or narrowly obovate, 15–45 × 3–8 mm, somewhat clasping at base, apex acute or slightly obtuse, margin entire, densely setulose; setae rigid, with multicellular, 1-layered bases. *Inflorescences* terminal; cymes scorpioid, bracteate. *Calyx* divided almost to base into 5 narrow lobes; lobes with apices acute, strongly strigose, accrescent, up to 12 mm long in fruit. *Corolla* white, infundibuliform; tube cylindric, 5–7 mm long, throat with 5 well-differentiated, longitudinal bands of hairs extending from bases of corolla lobes downwards to tips of anthers; lobes 5, rounded or truncate, ± 2 × 1 mm; annulus near base of corolla tube of scale-like lobes. *Stamens* 5, included, arising from corolla below middle of tube; filaments equal, shorter than anthers; anthers oblong, with short apical appendage. *Ovary* 4-lobed, 4-locular, gynobase disc-like; stigmas 2, subterminal. *Fruit* of 4 nutlets; nutlets erect, ovoid, flattened on dorsal side, keeled on ventral side, with ± straight beak, 2.5–3.0 mm long, rugose, tuberculate, attachment scar basal or nearly so; fruiting pedicel ± 2.5 mm long. *Flowering time*: August to December. Figure 3.

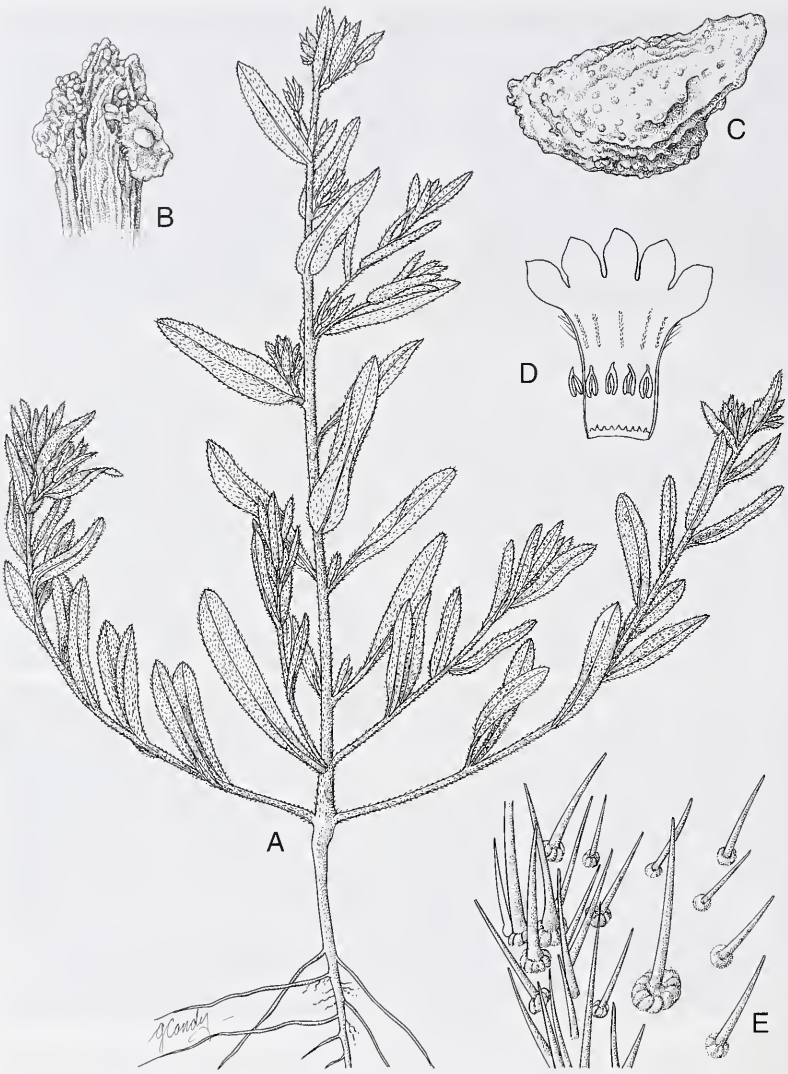

FIGURE 3.—*Buglossoides arvensis*. A, habit, × 0.65; B, stigma, × 13.6; C, tuberculate nutlet, × 12; D, corolla laid open, × 3.3; E, setae on upper leaf surface, × 34.5. A, C–E, *Acocks 19035*; B, *Acocks 17740*. Illustrations by Gillian Condy.

Distinguishing characters: annual herb, branching from base, appressed hairy; corolla infundibuliform, white, hairy inside; stigmas 2, subterminal; nutlets rugose, tuberculate.

Distribution: North-West, Gauteng, Mpumalanga, Free State, Lesotho, Northern Cape, Western Cape, Eastern Cape (Figure 4); a native of Eurasia, naturalized as a weed in many parts of the world.

Habitat: weed of waste places; also in disturbed areas such as in and along edges of cultivated lands.

Common names: sheepweed, white ironweed, gromwell, corn gromwell, gromwell-corncockle, puccoon; *naelbossie, naaldjiebossie, nagelbossie* (Afrikaans) (Smith 1966; Wells *et al*. 1986).

SPECIMENS EXAMINED (southern Africa only)

Acocks 17740 K, PRE; *17805* PRE; *19035* K, PRE; *40897* PRE. *Acocks & Roux 15948* K, PRE.

Bolus 101 BOL; *122* K; *274* GRA; *9201* BOL. *Bradfield 200* PRE. *Burchell 1686* K.

Dieterlen 1290 PRE.

Flanagan 1629 K, PRE. *Fourcade 941* BOL, GRA.

Gerrard 230 K.

Holub s.n. K.

Jenkins TRV7232 PRE.

Leendertz TRV9748 PRE. *Lovemore GRA-A1642* GRA.

MacOwan 1926 GRA. *Marloth 7216, 9670, PRE40898* PRE. *Mogg 15292* PRE. *Muir 790* PRE.

Schlechter 3550 GRA. *Sharpe 9145* PRE. *Silk 52* PRE. *Smith 884* PRE.

Tyson 378 GRA. *Trollope GRA-A1640* GRA.

Wardle PRE40893 PRE. *Wilman 19817, PRE59952* PRE. *Wilms 1006* BM. *Wolley-Dod 1551* K; *2794* BOL; *3611* BM, BOL, K.

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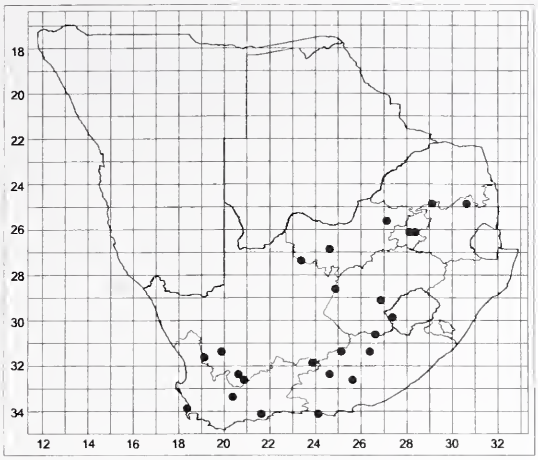

FIGURE 4.—Known distribution of *Buglossoides arvensis* in the *Flora of southern Africa* region.

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Bothalia 32,1: 15–19 (2002)

Studies in the liverwort family Aneuraceae (Metzgeriales) from southern Africa. 3. *Riccardia compacta*

S.M. PEROLD*

Keywords: Aneuraceae, *Riccardia* Gray, *R. compacta* (Steph.) S.W.Arnell, southern Africa, Tanzania

ABSTRACT

Riccardia compacta (Steph.) S.W.Arnell is described and illustrated. Its presently known distribution in southern Africa is indicated on an accompanying map. Some differences between local plants of the species and those from Tanzania are discussed.

INTRODUCTION

Riccardia compacta (Steph.) S.W.Arnell is the third species to be treated in the current revision of southern African taxa of this family. It was originally collected on Table Mountain by Jelinek, while on a Novara Expedition, and described as *Aneura compacta* by Stephani in 1893. Sim (1926) referred to it briefly, stating that it frequently occurred in forest districts throughout South Africa, which is doubtful, however, as it is apparently rare. Later on, two more specimens were collected on Table Mountain: one by Pillans, and the second by Arnell, who also collected it at Knysna. Arnell (1952) then transferred it to the genus *Riccardia*. During the 1950s Esterhuysen collected more specimens on high altitude peaks in Western Cape, but, regrettably, there have been no local collections since then. Arnell (1959) described an Esterhuysen specimen from Tanganyika (Tanzania) as *R. kilimandjarica* S.W.Arnell, which was placed in synonymy under *R. compacta* by Meenks & Pócs (1985). Pócs, either alone or with Ochyra, collected more material on Mt Kilimanjaro and Mt Meru during the 1980s. It was concluded by Meenks & Pócs that there were a few differences between Tanzanian plants of the species and the type specimen collected by Jelinek on Table Mountain. They also state that *R. compacta* is an Afro-alpine species which occurs at higher altitudes in East Africa than in South Africa.

Riccardia compacta (*Steph.*) *S.W.Arnell* in Botaniska Notiser 1952: 141 (1952); S.W.Arnell: 88 (1963); Meenks & Pócs: 84 (1985). Type: Cap, Tafelberg, *Jelinek*, Novara Expedition, (*19560G*, holo.!; EGR).

Aneura compacta Steph.: 19 (1893); Steph.: 755 (1901–1905); Sim: 29 (1926).

Thalli prostrate, in compact cushions or patches, up to 3 or 4 mm thick, in several overlying layers of dense and intricately intertwined, slightly rounded, narrow bands, quite fleshy and firm, but rather brittle, bright green, with an ill-defined, somewhat darker, narrow strip occupying median $^{1}/_{3}$ or more of branches; when dry, brown to dark brown. *Main axis* up to 15 mm long, not markedly differentiated, though often retaining its dominance, branching generally crowded and irregular (Figure 1A), sometimes bifurcate (Figure 1B), branches narrowing somewhat toward tips or maintaining same width throughout, rarely slightly dilated distally, apically ± truncate, shallowly notched, margins obtuse, not winged. *Primary branches/pinnae* arising laterally from axis, very close together or at intervals of 0.30–0.95 mm between successive ones, opposite or subopposite, obliquely spreading at angles up to 30° with axis, occasionally suberect, often relatively well developed, 2.0–3.5 mm long, up to 0.5 mm wide, usually linear, some bifurcate, rarely trifurcate, others poorly developed, almost rudimentary. *Secondary branches/pinnules* quite rare, if present, mostly remaining small. *Stolons* unbranched, generally arising on basal part of axis, occasionally developing more distally from apices of some primary branches. *Dorsal epidermal cells* in median part of apical segment of main axis (Figure 1C) from above 4–6-sided, thick-walled, 40–50 × 27.5–37.5 µm, subdorsal cells larger, 75–130 × 30.0–42.5 µm, subventral cells 50.0–87.5 × 15–20 µm, ventral epidermal cells 35–60 × 30–40 µm. *Oil bodies* not seen in material studied. *Margins* of apical segment of main axis (Figure 1D) entire, from above outer cells 25.0–37.5 × 27.5–35.0 µm, subquadrate to rectangular, intramarginal cells 5- or 6-sided, 32.5–50.0 × 27.5–37.5 µm, walls somewhat thickened. *Cross sections* of main axis at ± middle of ultimate segment (Figure 1E) and toward base (Figure 1F) biconvex, ± 180 µm, or 6/7 cell layers up to 240 µm, or 8 cell layers thick medianly, and up to 460 µm wide, margins tapering to obtuse, dorsal epidermal cells 27.5–30.0 µm high, medullary cells ovoid to almost spherical, sizes variable, 25–45 × 22.5–35.0 µm, walls thickened, ventral epidermal cells 30–35 µm high; cross section of primary branch at ± its middle (Figure 1G) plano-convex, ± 200 µm or 5/6 cell layers thick medianly, up to 475 µm wide, medullary cell walls slightly thickened; cross section of stolon (Figure 1H) oval, ± 160 µm or 6 cell layers thick medianly, ± 210 µm wide, cell walls somewhat thickened. *Mucilage papillae* ventral, clustered at emarginate apex of pinnae and then in two, spaced, acropetal rows, one on either side of midline, reddish brown, club-shaped, 62.5–75.0 × 20–25 µm above, narrower below, rarely persistent. *Rhizoids* in widely scattered, irregular patches along ventral surface of pinnae, hyaline, up to 15 µm wide. *Asexual reproduction* by gemmae not seen.

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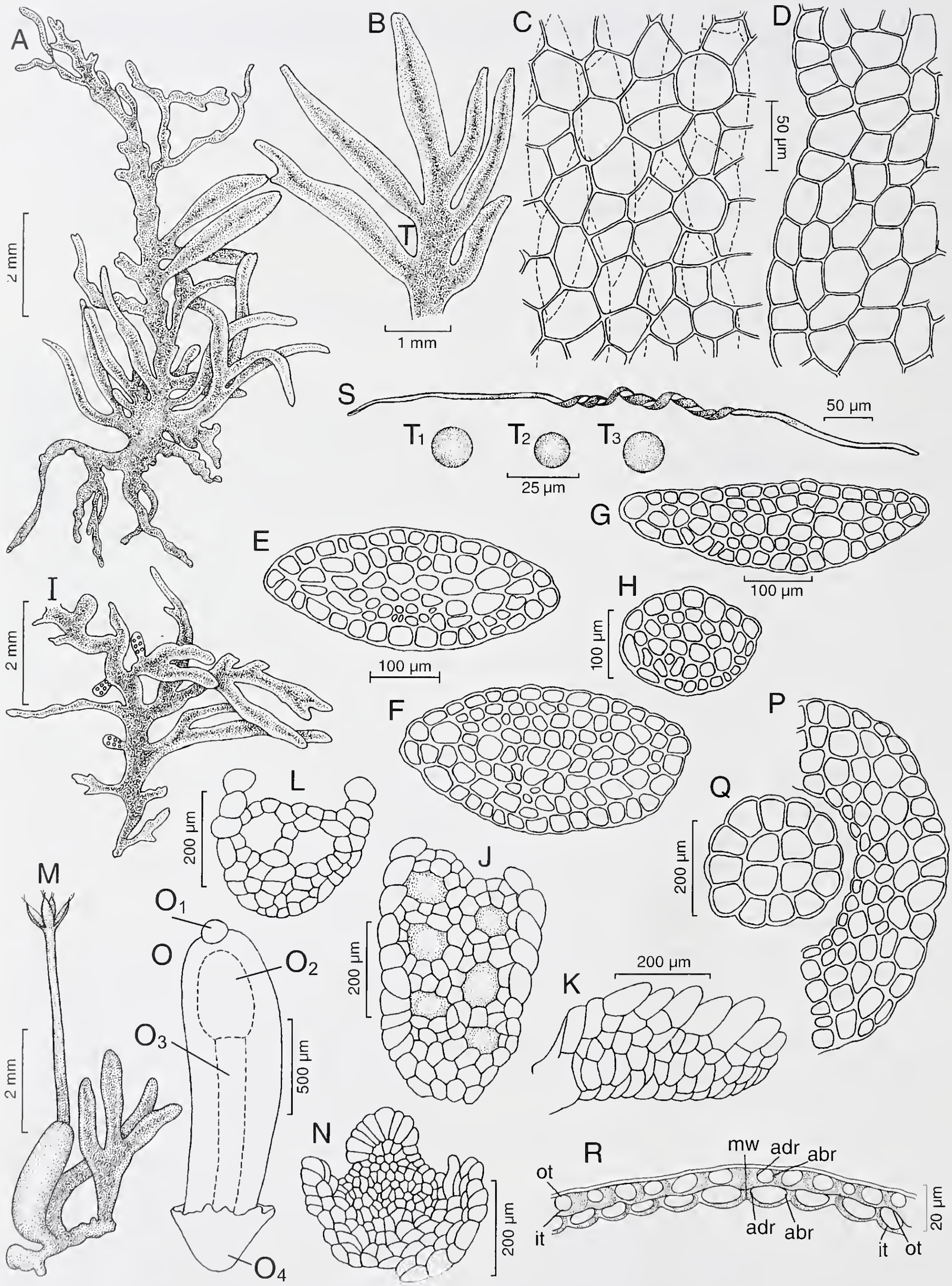

FIGURE 1.—*Riccardia compacta*. A, sterile thallus with axis and irregular lateral branches crowded below; B, axis with primary branches; C, median dorsal epidermal cells (solid lines) of ultimate segment of axis, and large subdorsal cells (stippled lines); D, margin of ultimate segment of axis; E, c/s axis at ± middle of ultimate segment; F, c/s axis below; G, c/s primary branch; H, c/s stolon; I, male thallus with 3 antheridial branches. J–L, antheridial branch: J, from above; K, from side; L, c/s. M, female thallus with calyptra, seta and dehisced capsule valves; N, gynoecial branch with very young calyptra and paraphyses. O, calyptra: O_1, corona; O_2, capsule; O_3, seta; O_4, basal portion. P, c/s calyptra wall; Q, c/s seta; R, c/s part of bistratose wall of capsule valve showing different cell walls: abr, abaxial radial; adr, adaxial radial; it, inner tangential; mw, median; ot, outer tangential. S, elater; T_{1-3}, spores. A–F, H–T, *Arnell 963*; G, *Jelinek 19560G*, holo.

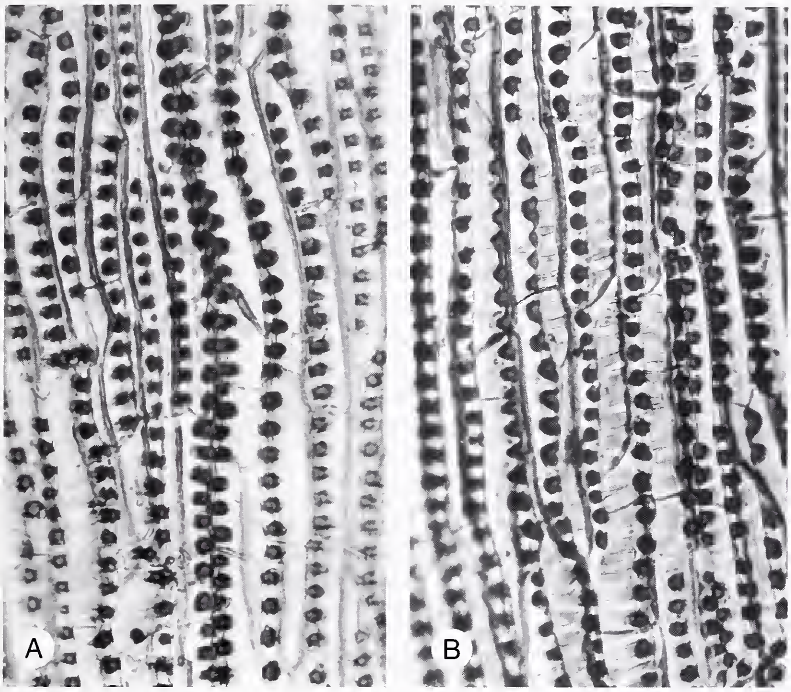

FIGURE 2.—A, cells of epidermal layer of wall of valve in external longitudinal view. B, cells of inner layer of wall of valve in internal longitudinal view. A, B, *Arnell 963*. A, B, × 446.

Dioicous. *Antheridial branches* solitary or occasionally in sympodial pairs, lateral on main axis opposite or subopposite primary branch, otherwise on primary branch close to its base (Figure 1I), stipitate, ± oblong (Figure 1J), up to 600 µm long, ± 320 µm wide, mostly bearing 3 or 4, rarely up to 8 pairs of antheridia, cavities 70–100 µm diam., encircled by 2 or 3 rows of cells, 25–30 × 30 µm; in cross section ± 250 µm high (Figure 1L), margins winged (Figure 1K), with single, incurved row of large, obliquely orientated cells, 75.0–112.5 × 40–45 µm, apically rounded and free, otherwise adjoining; ventral papillae up to 30 µm long, in lateral pairs, but rare. *Gynoecial branches* (Figure 1N) short and obliquely ventro-lateral on main axis, opposite or at base of primary branch, ± sessile, not seen with archegonia, only with very young calyptra, up to 500 µm long, including corona, the latter with apical row of radiating cells, width across widest part below 480–525 µm, including surrounding paraphyses, which are scale-like and dentate, with cells 40.0–52.5 × 27.5–30.0 µm. *Calyptra* (Figure 1M, O) clavate, up to 2.4 × 0.7 mm, cross section of wall ± 180 µm or 5/6 cell layers thick (Figure 1P), some outermost ones with low protrusions, at apex corona smoothly rounded above, cells thick-walled, dislodged at maturity by emerging capsule. *Seta* ± 6.5 mm long, ± 280 µm wide, with 4 central and an outer row of 12 cells, i.e. 4 cells diam. (Figure 1Q). *Capsule* ± ellipsoidal, 790–850 µm long, elaterophore internally attached to apex; valves 280–350 µm or 21–24 cell rows wide, cells of epidermal layer in external longitudinal view (Figure 2A), 55–110 × 10.0–12.5 µm, with strong vertical (radial) thickenings, evident as nodular brown bulges; in cross section (Figure 1R) cells rectangular, ± 7.5 µm thick, thickenings on adaxial radial and abaxial radial walls extending slightly onto outer and inner tangential walls, resulting in a crescentic ring of thickening, bands on one side of median wall alternating with those on the other side in a mirror image; inner cells in internal longitudinal view (Figure 2B) 67.5–85.0 × 12.5–17.5 (–20.0) µm, with nodular thickenings and with faint semiannular bands; in cross section (Figure 1R) cells ± 10 µm thick, thickened on adaxial radial and abaxial radial walls, extending slightly onto outer tangential walls and further across inner tangential walls. *Spores* (Figure $1T_{1-3}$) ± orbicular, 12.5–15.0 µm diam., translucent, scabrate. *Elaters* (Figure 1S) 97.5–317.5 × 7.5–10.0 µm, with single spiral band, tapering to unspiralled apical portions. *Chromosome no.*: n = unknown. [It was suggested by Hewson (1970), that the 'normal' number of n = 10 may be associated with the dioicous state and the monoicous state with double that number, i.e. 20].

DISCUSSION

The occurrence of *Riccardia compacta* in southern Africa appears to be restricted to Western Cape (Figure 3), generally at altitudes between 1 085 and 1 220 m, but it has also been collected close to sea level. It usually grows in wet, shady places, with low light intensity, on rotten wood, soil banks or on Table Mountain Sandstone.

The oil bodies were initially and briefly described by Arnell (1952) as 'rare, 3–8 × 8–22 µm, brownish' and he also illustrated a cell containing one (Arnell 1952: fig. 2h). In a much more detailed account, Meenks & Pócs (1985) observed that the oil bodies were 'rare or even absent in the epidermal cells and never in the cells of the wing'. They were, however, 'frequently present in the inner cells of the thallus', and were described by the above authors as 'light brown, 1 or 2 per cell', as well as 'globose to ellipsoid or bean-like, 8 × 8–30 × 12 µm'.

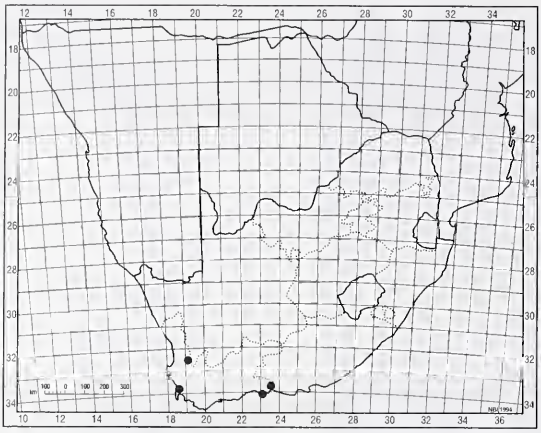

FIGURE 3.—Distribution of *Riccardia compacta* in southern Africa.

During a visit to Table Mountain (and other areas in Western Cape) in October 2000 by Perold & Koekemoer, we were unable to find fresh material in order to study the oil bodies. All the collections that I examined, had long ago lost their oil bodies. The colour of fresh plants could also not be observed, but Pillans had noted on the label of his collection from Table Mountain, that they were bright green and Meenks & Pócs (1985) stated that they were emerald green to dark brown.

In a comparison between plants from Tanzania and those from South Africa (with information reported by Arnell 1963), Meenks & Pócs (1985) found that the former specimens were generally longer at 20 mm versus 7 mm; in transverse section 6 or 7 cell layers thick, versus 4 or 5 cell layers; spore diameter 12–22 µm versus 12–14 µm; wing of main axis 1 cell wide, cells elongated, up to 75 × 40 µm, versus wing absent.

In my findings the thalli of our plants are up to 15 mm long and in cross section the ultimate segment of the main axis is 6 or 7 cell layers thick, the spore diameter is 12.5–15.0 µm, and the male branches are shorter at ± 600 µm long, with 3 or 4, rarely up to 8 pairs of antheridia; the wing is formed by a row of elongated, apically rounded cells that are laterally adjoined, but apically free. Male branches in the Tanzanian specimen that I studied are mostly longer than ours, i.e. up to 1600 µm long, with 4–14 pairs of antheridia, the wing consisting of a row of quadrate to rectangular cells, 42.5–45.0 µm high, 37.5–42.5 µm wide, their sides joined together right up to the edge; ventrally there are 2 rows of conspicuous red-brown mucilage papillae, up to 60 µm long, rarely seen in South African specimens. As Meenks & Pócs observed, there are a few differences between Tanzanian and South African plants. The general facies of the plants from the two areas is, however, closely similar and there is no doubt that they belong to the same species.

Meenks & Pócs expressed the opinion that all continental African records of *R. caespitans* (Steph.) E.W.Jones (nom. inval.) probably belong to *R. compacta*. Apparently, Jones (1956) had identified Hedberg specimens from Mt Muhawara, Uganda, as 'possibly *Aneura caespitans*', but had added that *R. caespitans* is 'known with certainty only from the Mascareignes' [Stephani (1892) Bourbon, leg. Rodriguez]. I have examined *Dusén G010680* from Cameroon, incorrectly labelled as 'TYPUS' with a red sticker, and also figure no. 236 in Stephani's *Icones hepaticarum* (1985), which was probably drawn from the aforesaid Dusén specimen (according to a note with it). This plant is decidedly different from *R. compacta* specimens: in cross section the ultimate segments of the main axis are 4 cell layers thick and winged, with 3 unistratose cell rows at both margins. The lower axis in cross section is 6 cell layers thick medianly and not 9 cells as in Stephani's *Icones hepaticarum*. Whether Dusén's specimen belongs to the same species as Rodriguez's type collection from Réunion, is very doubtful, as the latter species was reported by Stephani to be 10 cell layers thick medianly.

For several reasons I also hesitate to accept *R. kilimandjarica* as a synonym of *R. compacta*, as was done by Meenks & Pócs. In *R. kilimandjarica* the thalli appear to be lighter-coloured, lacking the central dark line, and more delicate than in *R. compacta*. Cross sections of the ultimate segment of the main axis are ± 500 µm wide and 5 or 6 cell layers rows (or 150–170 µm) thick, with the medullary cells clearly thin-walled, not thick-walled as in *R. compacta*.

Schuster (1963) suggested that a number of species, among them *R. compacta*, may be assigned to the subgenus *Phycaneura*, which is, however, characterized by relatively large, thin-walled dorsal epidermal cells. Although they had not studied specimens and illustrations of *R. compacta*, Brown & Braggins (1989) think that the species that Schuster (1963) grouped together, appear to be members of section *Alcicornia*, subgenus *Riccardia*, rather than of subgenus *Phycaneura*. Stephani (1899) had placed together some of these species, e.g. *A. alcicornis*, *A. compacta*, *A. diminuta*, *A. subsimplex*, *A. sumatrana* and others, as 'Plantae filiformes, subteretes'. *R. compacta* appears to bear some similarities to *R. subalpina* Furuki (1991) from Japan, as it also grows (mostly) at higher altitudes, and has small thalli and thick-walled cells.

R. compacta specimens are distinguished by the following characters: 1, the plants grow in dense, thick cushions of several layers of intricately intertwining branches, mostly at high altitudes; 2, the thalli are narrow and small, only up to ± 15 mm long, with irregularly branched, lateral branches, their margins generally parallel and unwinged; 3, from above the dorsal cells of the ultimate segment of the main axis are thick-walled, and in cross section, so are the medullary cells; 4, the antheridial branches in South African plants are usually short and have conspicuous marginal cells; and 5, the corona of the calyptra is smooth and the cells thick-walled.

SPECIMENS EXAMINED

R. compacta

Arnell 963, Table Mountain (S); *1623*, near Park Station, Knysna (BOL).

Esterhuysen 24253A, 24255, N side of Tsitsikama Mts (BOL); *25497,* Apollo Peak, Cederberg (BOL, PRE).

Jelínek 19560G (holotype), Table Mountain (G).

Pillans 4247, Table Mountain (BOL). *Pócs & Ochyra 88152/R,* Mt Meru, Tanzania (PRE).

Quite a few specimens (held at BOL, PRE & S) have been incorrectly referred to *R. compacta*, probably because of the small size of some of these plants. *Arnell 1689,* Gouna Forest, Knysna (PRE) is, in fact, *R. multifida* (Perold 2001).

R. kilimandjarica

Esterhuysen 27249 (holotype of *R. kilimandjarica*), Mt Kilimanjaro, Tanzania (S).

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Revision of the *Tarchonanthus camphoratus* complex (Asteraceae-Tarchonantheae) in southern Africa

P.P.J. HERMAN*

Keywords: Asteraceae, new species, resurrected names, revision, southern Africa, *Tarchonanthus camphoratus* L.

ABSTRACT

The *Tarchonanthus camphoratus* L. complex in southern Africa is revised. Five species are recognized on the grounds of differences in synflorescences, flowering times, leaf shape and margin, and distribution. Two names, *T. minor* Less. and *T. obovatus* DC., are resurrected and two new species, *T.* **littoralis** P.P.J.Herman and *T.* **parvicapitulatus** P.P.J.Herman, are described. A key, full descriptions of each taxon and distribution data are presented.

INTRODUCTION

Plants belonging to the *Tarchonanthus camphoratus* L. complex are well known in southern Africa and are commonly known as camphor bush/*kanferbos* (Afrikaans) (Smith 1966; De Winter *et al.* 1978) or African fleabane, camphor wood, sagewood, wild cotton, wild sage, *basterolien*, *bastervaalbos*, *bergvaalbos*, *kanferboom*, *kanferhout*, *kapokboom*, *kleinvaalbos*, *salie*, *saliehout*, *vaalbos*, *veldvaalbos*, *waaibos*, *wildesalie* and *witbos* (Afrikaans) (Wells *et al.* 1986), or camphor tree, *siriehout* (Afrikaans), *isiDuli selindle* (Xhosa), *isiDuli-sehlathi*, *iGqebe-elimhlophe* (Zulu), *mofahlana* (South Sotho), *mohatlha* (Tswana), *sefahla* (North Sotho), *mookga* (Venda) and *omutea* (Herero) (Palmer & Pitman 1972). Various parts of the plants are used medicinally (Watt & Breyer-Brandwijk 1962; Smith 1966; Palmer & Pitman 1972). The wood was used for turnery, boat-building, musical instruments, cabinet work, fence posts, shafts of spears and walking sticks (Smith 1966; Palmer & Pitman 1972; Coates Palgrave 1977). *Tarchonanthus camphoratus* is used as a fodder plant in dry areas (Smith 1966; Palmer & Pitman 1972; Tree Society of Southern Africa 1974). It is a very common element in some areas and some veldtypes have been named after it, e.g. the subdivisions of the Vryburg Shrub Bushveld by Acocks (1988) into the *Tarchonanthus* Veld of the Ghaap Plateau, the Mixed *Tarchonanthus* Veld of the Asbestos and Kuruman Hills, the Mixed *Tarchonanthus-Rhus-Croton* Veld of the Langeberg and the Mixed *Tarchonanthus*-Thornveld of the Kimberley plains and koppies. In all these cases, *Tarchonanthus camphoratus* L. *sens. str.* is involved.

A number of different names have been published for various *Tarchonanthus* taxa, but they were all put into synonymy under *T. camphoratus* by Paiva (1972) and subsequently by Hilliard (1977), Pope (1992) and Beentje (1999). Several workers maintained that there were different taxa under *T. camphoratus* (Acocks 1988; A. Gubb pers. comm.), with differences in palatability (Burchell 1824; A. Gubb pers. comm.). While I was preparing a manuscript for *Flowering Plants of Africa* (Herman & Condy 2001), it became clear that there were in fact a number of different taxa grouped under *T. camphoratus*. Differences in synflorescences, flowering times, leaf shape and margin and distribution, led to the recognition of five species. Two names are herewith resurrected and two new species described.

The septate hairs present in the capitula, which can be considered a generic characteristic for the genus, are described by Herman (2001). The descriptions of the leaf shapes are based on that proposed by Radford *et al.* (1974) and Radford (1986).

Key to species of *Tarchonanthus*

For the sake of completeness, *Tarchonanthus trilobus* (also occurring in southern Africa) is included in the key.

1a Involucral bracts of male and female capitula linear, free; adaxial leaf surfaces bullate (Figure 1A) . . . *T. trilobus*
1b Involucral bracts of male and female capitula lanceolate, elliptic, ovate or obovate, free, or of male capitula fused to ± halfway; adaxial leaf surfaces reticulate (Figure 1B):
  2a Capitula in dense, spicate, axillary or terminal clusters (Figure 2A, C); involucral bracts of male and female capitula free; peak flowering time September to December (spring to early summer). . . . . . 1. *T. minor*
  2b Capitula in lax, open panicles (Figure 2B, D); involucral bracts of male capitula fused to halfway, of female capitula free; peak flowering time February to August (late summer, autumn and winter):
    3a Leaf margins always entire:
      4a Leaves narrowly elliptic to slightly oblanceolate, acute or obtuse; cottony hairs enveloping cypselas creamy or yellowish; widespread . 3. *T. camphoratus*
      4b Leaves obovate or elliptic, obtuse or acute; cottony hairs enveloping cypselas pure white; restricted to Gordonia area (Northern Cape) mostly on iron stone or limestone base in sandy soils . . . 4. *T. obovatus*
    3b Leaf margins often faintly denticulate in upper part or entire:
      5a Leaves large, up to 140 × 45 mm; petioles up to 12 mm long; fruiting capitula large, up to 15 mm diam.; growing along coast from southern KwaZulu-Natal to Western Cape . . . . 2. *T. littoralis*
      5b Leaves smaller, up to 60 × 16 mm; petioles up to 5 mm long; fruiting capitula small, up to 10 mm diam.;

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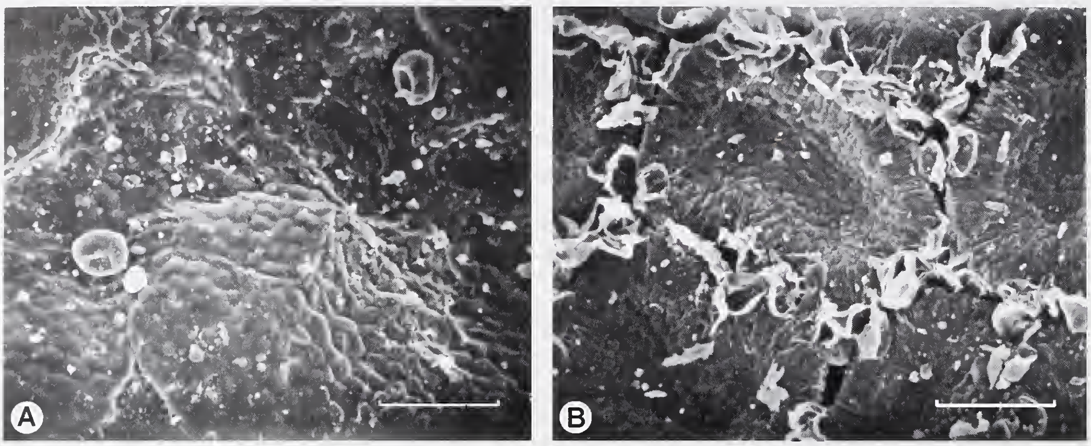

FIGURE 1.—Scanning electron micrographs of adaxial leaf surfaces of *Tarchonanthus* species. A, bullate surface of *T. trilobus* var. *trilobus*, *Strey 9016* (PRE); B, reticulate surface of *T. minor*, *Leistner 495* (PRE). Scale bars: 100 μm.

growing inland, occurring in forests, valleys or bushveld on mountain slopes, hills and river banks; Northern Province, North-West, Gauteng, Mpumalanga, Swaziland and KwaZulu-Natal . . . . 5. *T. parvicapitulatus*

1. **Tarchonanthus minor** *Less.*, Synopsis generum Compositarum: 208 (1832); DC.: 431 (1836); Harv.: 118 (1865). Type: South Africa, [Orange] Free State, 2925 Jagersfontein, Fauresmith, under edge of plateau of Langeberg, (–CB), NW slope, 21 October 1925, *Smith 942* (PRE!, neotype, here designated).

T. angustissimus DC.: 431 (1836). Syntype: South Africa, [Northern] Cape, Philipstown, on the Table Mountain, near Horse's Grave (= Paardeberg), ??Karrapoort, *Burchell 2691* [G-DC; K!, lecto. chosen by Beentje: Kew Bulletin 54,1: 83 (1999)–PRE photo.!].

Dioecious shrub or small tree up to 5 m high. *Leaves* aromatic, alternate, small, narrowly elliptic (Figure 3A), 10–40(–52) × 2.5–15.0 mm, discolorous, upper surface bright to dark green, pubescent when young, becoming glabrous except for hairs in lower half of furrow caused by sunken main vein, reticulate, with golden glands on margins of reticulations (Figure 1B), lower surface densely whitish tomentose; apex acute, often mucronate subapically; base cuneate; margin entire, rarely denticulate. *Petiole* 1–3(rarely up to 5) mm long. *Synflorescences* dense, spicate, axillary and terminal clusters (Figure 2A, C). *Male plants*: capitula homogamous discoid, 7–12 mm diam., 15–80-flowered, sessile. *Involucral bracts* densely hairy, free, in ± 3 rows, imbricate; outer ovate, acute to acuminate, up to 7 × 5 mm; middle row ovate, acute or obovate, 4 × 3 mm; inner row linear, 5 × 0.5 mm. *Corolla* infundibuliform, hairy and glandular; tube 5–6 mm long; lobes 5, 1.5–2.0 mm long, recurved, papillate. *Anthers* exserted, with ovate apical appendage, calcarate, caudate, tails ± 1 mm long, branched; filaments 1.5 mm long. *Style* up to 6 mm long, well exserted, undivided or with 2 very small lobes, papillate. *Ovary* narrowly oblong, sterile, with long, septate hairs. *Female plants*: capitula homogamous discoid, 6–10 mm diam., 1–11-flowered, sessile or peduncle up to 3 mm long. *Involucral bracts* densely hairy, free, in 2 or 3 rows; outer ovate, acute or obovate, obtuse, 4–7 mm long; middle row obovate, obtuse or acute, 5–7 mm long; inner row oblanceolate, 4–7 mm long. *Corolla* infundibuliform, hairy and glandular; tube 1.5–2.0 mm long; lobes 5, 1.0–1.5 mm long, papillate, recurved. *Style* well exserted, 4 mm long, with 2 broad, 0.5–1.0 mm long lobes. *Ovary* elliptic, 3–4 mm long, glandular and septate-hairy. *Cypsela* enveloped by long, white, silky, septate hairs. *Pappus* absent. *Flowering time*: August to December with a peak from September to December (spring to early summer).

Distribution and habitat: Tarchonanthus minor occurs in the Free State, Lesotho, Northern, Western and Eastern Cape on hillslopes, mountainsides, rocky ridges and hills (Figure 4).

Vernacular names: small-leaf camphor bush, *kleinblaarkanferbos* (Afrikaans) are here proposed.

Notes: 1) Lessing described *T. minor* in 1832 but cited no specimen (see also Pope 1992); neither did De Candolle (1836), but only referred to Lessing's description. Beentje (1999) stated that the plants Lessing saw, were destroyed at B. Harvey (1865) cited a few specimens. I chose *Smith 942* as neotype as Smith made a note on his specimen: 'Agrees in shape and size of leaves with *Cooper 708* cited by Harvey in *Flora capensis* 3: 118 under *T. minor* Less., but Cooper specimen is barren'.

2) The name 'minor' has been misapplied to almost all species of *Tarchonanthus* recognized here. *Tarchonanthus minor* is distinguished from the other species by the small, narrowly elliptic, entire leaves, dense, spicate synflorescences and flowering time in spring and summer. The leaves in some of the Lesotho specimens reach the upper limit of the range in leaf size.

2. **Tarchonanthus littoralis** *P.P.J.Herman*, sp. nov., *T. camphoratus* L. affinis sed folia magna, oblanceolata, elliptica ad anguste elliptica, raro obovata, (32–)40–140 × 10–45 mm, bicoloria, supra atrovirentia,

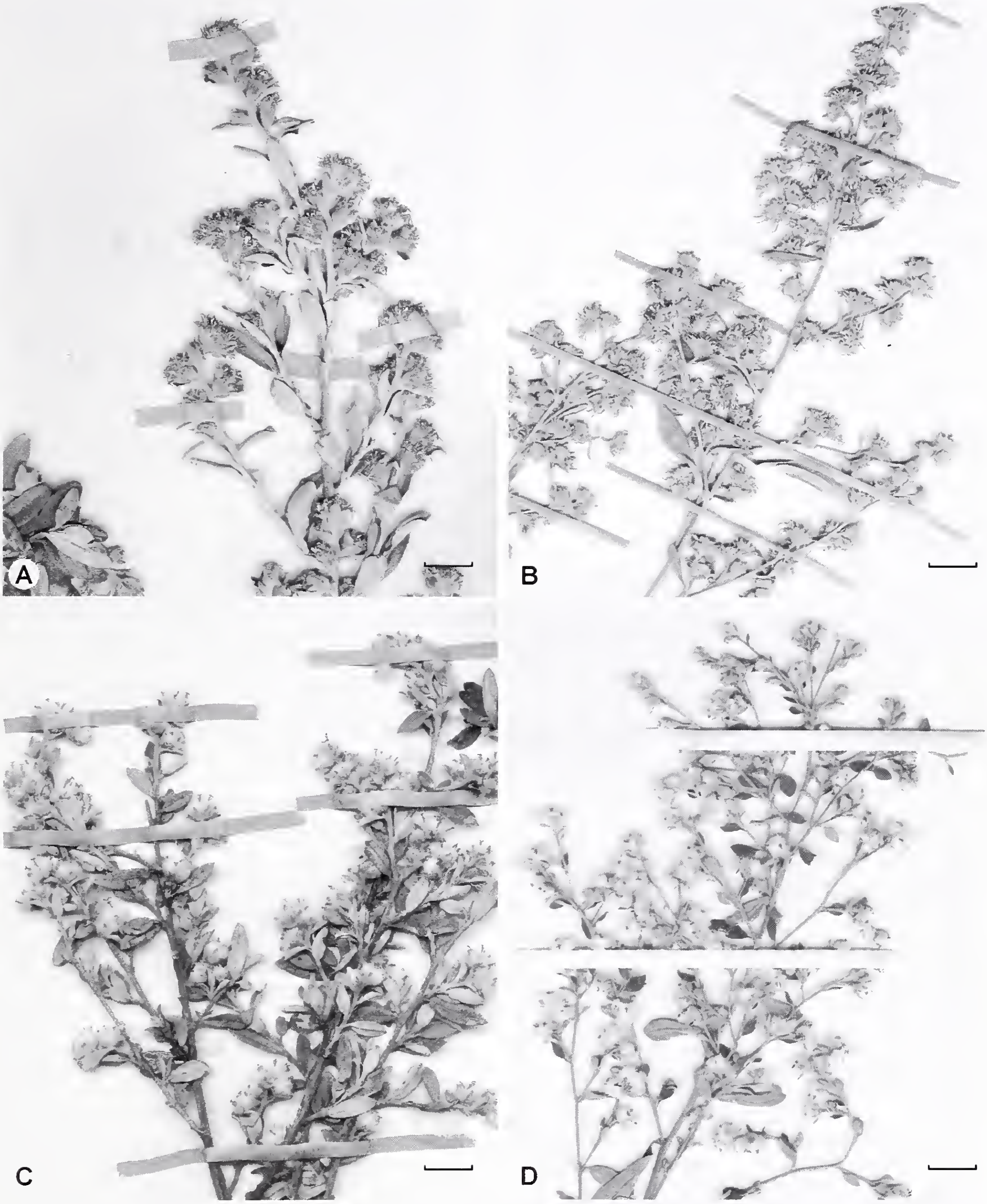

FIGURE 2.—Synflorescences of *Tarchonanthus* species. A, dense, spicate male synflorescences of *T. minor, Galpin 13954* (PRE); B, paniculate male synflorescences of *T. camphoratus, Story 1057* (PRE); C, dense, spicate female synflorescences of *T. minor, Liebenberg 7377* (PRE); D, paniculate female synflorescences of *T. parvicapitulatus, Botha 2660* (PRE). Scale bars: 10 mm.

infra albida; margine integra vel plerumque apicem versus leviter denticulato; petiolus 5–8(–12) mm longus; cypsela pilis involvens albidis; plerumque littora incolens.

TYPE.—South Africa, [KwaZulu-]Natal, 3030 Port Shepstone, Uvongo, Deppe's road, (–CB), 10 March 1970, *Strey 9713* (PRE, holo.!).

Dioecious shrubs or trees, 1–8 m high. *Leaves* aromatic, alternate, large, oblanceolate, elliptic to narrowly elliptic, rarely obovate (Figure 3B, C), (32–)40–140 ×

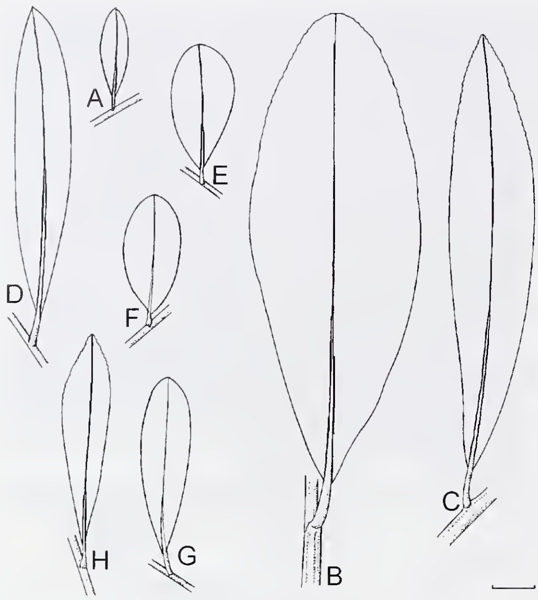

FIGURE 3.—Leaf shapes of *Tarchonanthus* species. A, small, narrowly elliptic, entire leaf of *T. minor, Braack 22* (PRE). B, C, *Tarchonanthus littoralis*: B, large, narrowly elliptic leaf, *O'Callaghan, Fellingham & Van Wyk 186* (PRE); C, oblanceolate leaf with denticulate margins, *Osborne 18* (PRE). D, narrowly elliptic, entire leaf of *T. camphoratus, Germishuizen 369* (PRE). E, F, *Tarchonanthus obovatus*: E, obovate, entire leaf, *Gubb 1562* (KMG); F, elliptic, entire leaf, *Gubb 1519* (KMG). G, H, *Tarchonanthus parvicapitulatus*: G, oblanceolate, obtuse leaf with entire margins, *Mogg PRE43479* (PRE); H, oblanceolate, obtuse-mucronate leaf with denticulate margins, *Compton 27888* (PRE). Scale bar: 10 mm. Drawn by G. Condy.

10–45 mm, discolorous, upper surface bright or dark green, hairy when young, becoming glabrous, reticulate, with glands on margins of reticulations, main vein sunken and hairy, especially in lower half, lower surface densely white-hairy, main and secondary veins conspicuous; apex obtuse to acute, sometimes with curved mucro subapically; base cuneate; margin very often faintly denticulate in upper part, rarely entire. *Petiole* 5–8(–12) mm long. *Synflorescences* terminal, paniculate. *Male plants*: capitula homogamous discoid, 5–10 mm diam., 13–47-flowered; peduncle 2–12 mm long. *Involucral bracts* densely hairy, fused halfway, 5-lobed; tube 1.5–3.0 mm long; lobes 1.5–2.0 mm long; sometimes with few free, inner bracts. *Corolla* infundibuliform, glandular and hairy; tube 2.0–3.5 mm long; lobes 5, 1.0–1.5 mm long, papillate, recurved. *Anthers* 1.0–1.5 mm, exserted, with ovate-triangular, apical appendage, calcarate, caudate, tails ± 0.5 mm long, branched; filaments 1.5–3.0 mm long. *Style* well exserted, 5–8 mm long, undivided or with 2 small lobes, papillate. *Ovary* rod-like, 0.5–1.0 mm long, glandular, sterile, septate-hairy. *Female plants*: capitula homogamous discoid, ± 5 mm diam., mostly 3(–6)-flowered; peduncle 0–4 mm long. *Involucral bracts* free, 3–6 mm long, in 2 or 3 rows; outer bracts ovate or narrowly lanceolate-ovate, acute; inner elliptic. *Corolla* infundibuliform, glandular and hairy; tube 1.5–2.0 mm long; lobes 5(6), 0.5–1.0 mm long, papillate, recurved. *Style* exserted, 2.5–3.5 mm

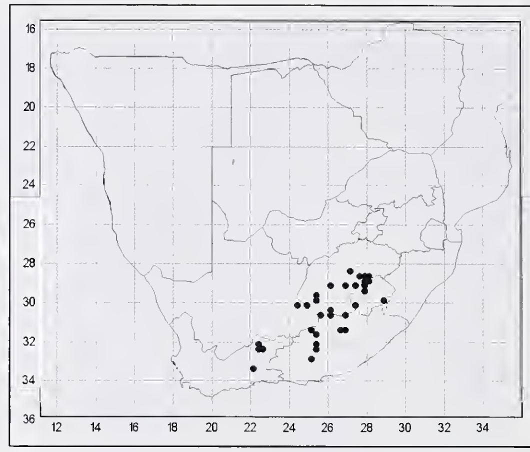

FIGURE 4.—Distribution of *T. minor* in southern Africa based on material at PRE.

long, with 2 short branches, ± 1 mm long. *Ovary* elliptic to obovate, 2.5–4.0 mm long, densely septate-hairy and glandular. *Cypsela* obovate to elliptic, ribbed, 3–5 mm long, densely, white, septate-hairy and glandular. *Pappus* absent. *Flowering time*: December to July with a peak from February to March (July) (late summer).

Distribution and habitat: *Tarchonanthus littoralis* occurs from southern KwaZulu-Natal to Eastern and Western Cape along the coast, on hillsides, littoral dunes and river banks (Figure 5).

Vernacular names: coastal camphor bush, *kuskanferbos* (Afrikaans), are here proposed.

Tarchonanthus littoralis is distinguished by the usually large, oblanceolate to elliptic or narrowly elliptic, dark green leaves with mostly denticulate upper margins and long petiole. The cypsela-containing capitula are rather

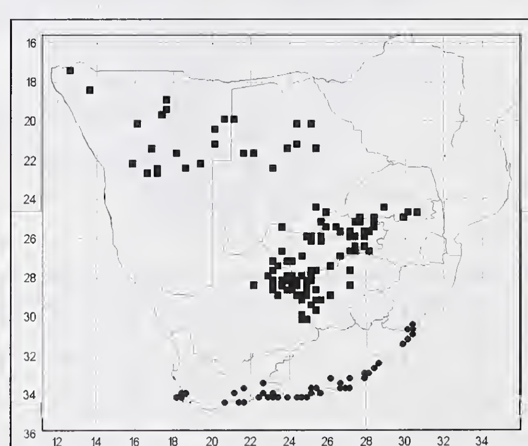

FIGURE 5.—Distribution in southern Africa of *T. littoralis*, ●, based on material at PRE; and *T. camphoratus*, ■, based on material at KMG and PRE.

large. This is probably the species described and illustrated by Von Breitenbach (1974) under *T. camphoratus*. It has often been confused with *Brachylaena* species.

3. **Tarchonanthus camphoratus** *L.*, sens. str., Species plantarum: 842 (1753); Less.: 208 (1832); DC.: 431 (1836); Harv.: 118 (1865); Merxm.: 176 (1967); Paiva: 360 (1972); Compton: 622 (1976); Hilliard: 111 (1977); Pope: 9 (1992); Beentje: 82 (1999). Type: 'Aethiopia', in this case South Africa; Hort. Cliff. has 'Cap. Bon. Sp.' (*Herb. Cliff. 398, Tarchonanthus no.1*, BM, lectotype chosen by Anderberg in Jarvis et al. 1993: 92, see Beentje 1999–PRE, photo.!).

T. litakunensis DC.: 431 (1836); excluding lectotype chosen by Beentje (1999), here placed under *T. littoralis*. Lectotype: *Burchell 2202* (G-DC, here designated–PRE, photo.!).

T. camphoratus L. var. *litakunensis* (DC.) Harv.: 118 (1865).

Mostly a multi-stemmed, rounded dioecious shrub, rarely a tree, 1–8 m high. *Leaves* aromatic, alternate, narrowly elliptic to slightly oblanceolate (Figure 3D), (20–)26–80 × 7–20 mm, discolorous, upper surface grey-green or khaki-green, hairy when young, becoming glabrous, reticulate, with glands on margins of reticulations, main vein sunken, hairy in lower part, lower surface densely grey- or greenish hairy, main and secondary veins prominent, tertiary veins reticulate; apex acute, often mucronate, sometimes obtuse; base cuneate; margin entire. *Petiole* up to 5 mm long. *Synflorescences* terminal, paniculate (Figure 2B). *Male plants*: capitula homogamous discoid, 3.0–11.5 mm diam., 10–60-flowered; peduncle 0–10 mm long. *Involucral bracts* fused halfway, 5(–7)-lobed; tube 1.5–5.0 mm long; lobes 1.0–2.5 mm long, sometimes with a few free bracts on inside. *Corolla* infundibuliform, glandular and hairy; tube 1.5–3.5 mm long; lobes 5, 0.5–1.0 mm long, papillate, recurved. *Anthers* well exserted, 1.0–1.5 mm long, with small, ovate, apical appendage, calcarate, caudate, tails up to 0.5 mm long, branched; filaments 2–3 mm long. *Style* well exserted, 4–8 mm long, undivided or rarely with 2 small lobes, papillate. *Ovary* rod-like, 0.5–1.0 mm, sterile, septate-hairy. *Female plants*: capitula homogamous discoid, 3.5–7.0 mm diam., (1–)3(–5)-flowered; peduncle 0–6 mm long. *Involucral bracts* densely hairy, in 2 or 3 rows, free, imbricate, 3–6 mm long; outer bracts linear-lanceolate to linear-obovate; middle and inner row ovate. *Corolla* infundibuliform, hairy and glandular; tube 1.0–1.5 mm long; lobes 5, 0.5 mm long, papillate. *Staminodes* sometimes present. *Style* exserted, 1.5–3.0 mm long, with 2 broad, 0.5 mm long lobes. *Ovary* elliptic to obovate, 1–4 mm long, densely septate-hairy and glandular. *Cypsela* elliptic, ribbed, 3–4 mm long, creamy or yellowish, densely septate-hairy and glandular. *Pappus* absent. *Flowering time*: March to August with a peak from March to July (autumn to winter).

Distribution and habitat: *Tarchonanthus camphoratus* is widely distributed in the northern part of southern Africa from Namibia, Botswana, the Northern Province, North-West, Gauteng, Free State and Northern Cape (Figure 5). It also occurs in tropical and North Africa and the Arabian Peninsula. It occurs in a variety of habitats and soil types, e.g. savanna, bushveld, woodland, grassland, on flats, rocky hills, mountain slopes and hillsides, riverbanks on sandy, loamy, gravelly, calcrete, quartzite and dolomitic soils.

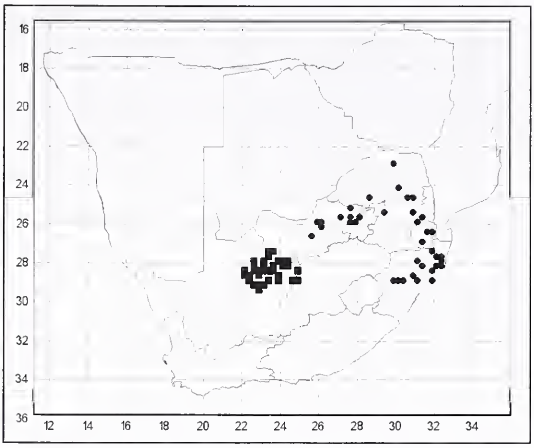

FIGURE 6.—Distribution in southern Africa of *T. obovatus*, ■, based on material at KMG and PRE; and *T. parvicapitulatus*, ●, based on material at PRE.

Vernacular names: camphor bush, *kanferbos* (Afrikaans) as listed by De Winter *et al.* (1978) is proposed for *T. camphoratus sens. str.*

Notes: 1) It is very unfortunate that Beentje (1999) chose *Drège 5041* as lectotype for *T. litakunensis*. 'Litakun' (Takoon 2723BB) is a small settlement near Kuruman (Burchell 1824; Leistner & Morris 1976) in the North-West. However, *T. littoralis* always grows near the sea and the specimen chosen by Beentje (*Drège 5041*) was collected near the sea. This specimen (*Drège 5041*) also conforms to the description of *T. littoralis* presented here. It is therefore proposed that *Drège 5041* be rejected as lectotype of *T. litakunensis*.

2) This is the most common taxon of the genus in the northen parts of southern Africa. It can be distinguished by the narrowly elliptic to slightly oblanceolate, entire leaves with a grey-green or khaki-green colour and the cypselas enveloped by yellowish cottony hairs. Not browsed by stock (Burchell 1824) except as a last resort in times of drought [A. Gubb pers. comm., *Speedy 11/22* (PRE)].

4. **Tarchonanthus obovatus** *DC.*, Prodromus 5: 431 (1836), Herman & Condy: 108, t. 2180 (2001). Type: South Africa, Bechuanaland Division (?Northern Cape), Klipfontein, *Burchell 2155* (G-DC, holo.; K!–PRE, photo.!).

Mostly a single-stemmed dioecious tree or rarely a shrub, up to 2 m high. *Leaves* aromatic, alternate, obovate or elliptic (Figure 3E, F), 12–32(–37) × 7–17 mm, discolorous, upper surface bright green, hairy when young, becoming glabrous, reticulate, glandular in reticulations, main vein sunken and hairy in lower part, lower surface densely whitish pubescent, main and secondary veins prominent, minor veins forming a reticulation; apex obtuse or acute; base cuneate; margin entire. *Petiole*

1.0–4.0 mm long. *Synflorescences* terminal, paniculate. *Male plants*: capitula homogamous discoid, 8–11 mm diam., 20–40-flowered; peduncle 0–7 mm long. *Involucral bracts* fused halfway, 5-lobed; tube 2.0–2.5 mm long; lobes 2.0–2.5 mm long. *Corolla* infundibuliform, hairy and glandular; tube 1.5–2.5 mm long; lobes 5(6), 1.0–1.5 mm long, papillate. *Anthers* 5(6), exserted, 1.0–1.5 mm long, calcarate, caudate, tails ± 0.5 mm long, branched; filaments 2–3 mm long. *Style* well exserted, 6–7 mm long, undivided or with 2 small lobes, ± 0.5 mm long, papillate. *Ovary* rod-shaped, 0.5–1.0 mm long, densely septate-hairy and glandular, sterile. *Female plants*: capitula homogamous discoid, 3.5–4.5 mm diam., 2–5-flowered; peduncle 0–7 mm long. *Involucral bracts* free, in 2 or 3 rows, 3–6 mm long; outer bracts obovate, acute; inner spathulate or narrowly obovate, acute. *Corolla* infundibuliform, glandular and hairy; tube 0.5–1.0 mm long; lobes 5(6), ± 0.5 mm long, apex papillate. *Style* exserted, 1.0–2.0 mm long; style branches 0.5 mm long. *Ovary* obovate, 2–3 mm long, glandular and septate-hairy. *Cypsela* brown, obovate, ribbed, 2.5–5.0 mm long, glandular and pure white, septate-hairy. *Pappus* absent. *Flowering time*: March to May (autumn to early winter).

Distribution and habitat: Tarchonanthus obovatus is restricted to Northern Cape where it occurs on hillsides, rocky outcrops or flats often on an ironstone or limestone base in sandy soils (Figure 6).

Vernacular names: Gordonia camphor tree, *Gordonia-kanferboom* (Afrikaans), was proposed for this taxon (Herman & Condy 2001). It is known by farmers in that region as *olienvaalbos* (Afrikaans) (A. Gubb pers. comm.), but *vaalbos* refers to *Brachylaena* species (De Winter *et al.* 1978).

Note: it is interesting that, since the description, the name *T. obovatus* has never been used. This species is recognized by the obovate or elliptic, entire leaves and the cypselas that are enveloped by pure white, cottony hairs in contrast to *T. camphoratus*, occurring in the same area, which have yellowish hairs enveloping the cypselas. Readily browsed by both game and domestic stock all year round (A. Gubb pers. comm.).

5. **Tarchonanthus parvicapitulatus** *P.P.J.Herman*, sp. nov., *T. camphoratus* L. affinis sed folia oblanceolata, raro obovata, (22–)25–60(–70) mm, margine integra vel plerumque apicem versus leviter denticulato; capitula parva; synflorescentia laxa.

TYPE.—South Africa, Transvaal [Mpumalanga], 2531 Komatipoort, Barberton, (–CC), lower hill slopes, April 1890, *Galpin 952* (female plant) (PRE, holo.!).

Dioecious shrub or small, multi-stemmed tree, up to 8 m high. *Leaves* aromatic, alternate, oblanceolate or rarely obovate (Figure 3G, H), (22–)25–60(–70) × 7–16 mm, discolorous, upper surface pale, dark green, hairy when young, becoming glabrous, glandular in reticulations, midrib sunken and hairy in lower part, lower surface densely whitish hairy, main and secondary veins prominent; apex obtuse to obtuse-mucronate, sometimes acute; base cuneate; margin often faintly denticulate in upper part, rarely entire. *Petiole* 1.5–5.0 mm long. *Synflorescences* terminal, paniculate (Figure 2D). *Male plants*: capitula homogamous discoid, 5–9 mm diam., 10–30-flowered; peduncle 0–7 mm long. *Involucral bracts* fused halfway, 5-lobed; tube 1–2 mm long; lobes 1.0–1.5 mm long. *Corolla* infundibuliform, glandular and hairy; tube 1.5–2.0 mm long; lobes 5, 1.0–1.5 mm long, apex papillate. *Anthers* 5, exserted, 1.0–1.5 mm long, calcarate, caudate, tails 0.5 mm long, branched; filaments 2–3 mm long. *Style* well exserted, 4.0–5.5 mm long, entire or with 2 small lobes. *Ovary* rod-shaped, 0.5 mm long, sterile, septate-hairy. *Female plants*: capitula homogamous discoid, 3–4 mm diam., 1–3-flowered; peduncle mostly absent or up to 5 mm long. *Involucral bracts* free, 2–5 mm long, in 2 or 3 rows, narrowly lanceolate, narrowly ovate or elliptic, acute. *Corolla* infundibuliform, glandular and hairy; tube 0.5–1.0 mm long; lobes (4)5, 0.5–1.0 mm long, papillate. *Style* exserted, 1–2 mm long, lobes 2, 0.5 mm long. *Ovary* obovate to elliptic, 1.5–3.5 mm long, glandular and septate-hairy. *Cypsela* pale or dark brown, obovate, ribbed, 1.5–3.0 mm long, glandular and pure white, septate-hairy. *Pappus* absent. *Flowering time*: March to October with a peak from April to June (autumn to winter).

Distribution and habitat: *Tarchonanthus parvicapitulatus* occurs in Namibia(?), Northern Province, the North-West, Gauteng, Mpumalanga, Swaziland, KwaZulu-Natal and Eastern Cape (only 2 records) (Figure 6). It is also found in Zimbabwe (cf. *Borle 157*, *Sim 19129*, *Miller 1776*, *Ngoni 370*, *Wild 1048*). It grows in forest, valleys and bushveld on mountain slopes, hills and river banks.

Vernacular names: small-head camphor bush, *kleinhofiekanferbos* (Afrikaans) are here proposed.

Note: this species is recognized by the oblanceolate, obtuse-mucronate leaves mostly with denticulate margins towards the apex. The synflorescences tend to be more open and the capitula are smaller than in the other species. This is probably the species referred to by Moll (1992) under *T. camphoratus*.

SPECIMENS EXAMINED

f, female; m, male.

Acocks 535 (3) (f & m), *543* (3) (f) PRE; *2109* (4) (f), *2117* (3) (m), *2344*, *2351*, *2352* (3) (f) KMG, PRE; *8617*, *8627* (2) (f), *13010* (5) (m) PRE; *KMG11730* (2) (f) KMG. *Alexander PRE43490* (2) (f & m) PRE. *Allen 131* (3) (m) PRE. *E.R. Anderson J.14* (3) (m) PRE. *J. Anderson 58* (1) (f & m) PRE. *J.R. Anderson ORFS233* (1) (m) PRE. *Archibald 3595* (2) (f) PRE.

M. Badenhorst 509 (3) (m) KMG. *P.J. Badenhorst 40*, *104* (3) (f) KMG, PRE. *Balsinhas & Kersberg 1948* (3) (f) PRE. *N. Barker 886* (5) (m) PRE. *N.P. Barker 621* (3) (m) PRE. *Capt. Barrett-Hamilton TRV6408* (3) (f) PRE. *Basson 14* (3) (f) PRE. *Bayliss BRI.B.351* (3), *BRI.B.6249* (2), *BS8416* (2) (m) PRE. *Bengis 447* (1) (f) PRE. *Biggs 222* (5) (m) PRE. *Boddam-Whetham 60* (1) (f) PRE. *Bosch 154* (4) (f) KMG. *Botha 2559* (3) (f), *2660* (5) (f), *3067* (2) (m) PRE. *Braack 22* (1) (m) PRE. *Bradfield 250* (3) (m) PRE. *Britten 33*, *736* (2) (f) PRE. *A. Brueckner 845* (3) (m) KMG, PRE. *Burchell 2155* (4) (f & m) K, *2691* (1) (sterile) K. *Burrows 2102* (1) (m), *2286* (1) (f) PRE. *Burtt Davy 148*, *10741*, *13933* (3) (f), *317* (5) (m), *7865* (2) (f), *9531*, *10375*, *13820* (3) (m) PRE.

Codd 1166 (5) (f), *1169, 1935* (5) (m), *1283* (4) (f), *1283* (3) (m) PRE. *Collett 510* (3) (m) PRE. *E. Collins PRE43484* (5) (m) PRE. *S. Collins 12* (3) (m) PRE. *Comins 1053* (2) (f) PRE. *Compton 26015, 27888, 28810, 32132* (5) (f), *28947* (5) (m) PRE. *E.O. Cooke 6271* (3) (m) KMG. *O.L. Cooke 4265* (4) (m) KMG, *6266* collected 4/1940 (4) (m) PRE, *6266* collected 4/1942 (4) (m), *6267* collected 4/1942 (4) (f) KMG. *Culverwell 23* (5) (m) PRE.

Dahlstrand 420 (2) (f) PRE. *Davies, Thompson & Miller 8, 89* (3) (f) PRE. *De Souza 441* (5) (m) PRE. *De Villiers PRE43498* (3) (f & m) PRE. *De Winter 2834, 3520* (5) (m), *9256* (2) (f) PRE. *De Winter & Leistner 5636* (3) (f) PRE. *Dieterlen 565* (1) (m) PRE. *Dinter 4723* (3) (m) PRE. *Dix 211* (2) (m) PRE. *Downing 560* (5) (m) PRE. *Dregè s.n. (5041)* (2) (f) K; *PRE9727* (2) (f) PRE. *Du Preez & Steenkamp 114* (3) (f) PRE.

Ecklon & Zeyher 112.11 (1) (m) PRE. *D. Edwards 2062* (5) (f), *2505* (5) (m), *4413* (3) (f) PRE. *H.W.G. Edwards 52* (5) (f) PRE. *C. Evrard 9276* (3) (f) PRE.

Farquharson A1483 (2) (f) PRE. *Feely 32* (5) (m) PRE. *Fellingham 963* (2) (f) PRE. *Flanagan 192* (2) (f & m), *350* (2) (f), *1551* (1) (f), *2330* (5) (m) PRE. *Fourie ORFS174* (1) (m) PRE.

Galpin 952 (5) (f & m), *7008* (3) (f), *13954* (1) (m), *133127* (5) (f), *M184* (3) (m) PRE. *Gane 268* (2) (f) PRE. *Germishuizen 369* (3) (f & m), *387* (5) (f) PRE. *Gerrard 1022* (2) (m) K (mounted with type). *Gerstner 593* (5) (m), *659* (5) (f) PRE. *Giess 11693* (3) (f) PRE. *Gilfillan Herb. Galpin 5533* (1) (m) PRE. *Gillett 3434* (2) (m) PRE. *Glen 2761* (5) (f) PRE. *Goldblatt 1424* (2) (f & m), *8013* (2) (f) PRE. *Goossens 710* (1) (f), *1673* (3) (f) PRE. *Gubb 16* (4) (f), *18* (3) (m) KMG; *168-1, 219/1, 260-84, 272-2* (4) (f) PRE; *341* (3) (m & f), *342, 343* (3) (f), *344* (4) (f), *345, 346* (3) (f), *347* (3) (m), *349* (3) (m & f), *350* (3) (f), *351* (4) (m), *352, 353, 355* (4) (f), *1088* (3) (m), *1097* (4) (f), *1328, 1439* (4) (m), *1507* (4) (f), *1513* (4) (m), *1519, 1530* (4) (f), *1562, 1703* (4) (m), *1727* (3) (m), *2105* (4) (m), *2221, 2222* (3) (f), *2243* (4) (f), *3603* (3) (m), *4361, 6002, 6516* (4) (f), *7442* (3) (m), *8118, 13680, 14303, 16125, 16127* (4) (f), *16128* (4) (m), *16130* (3) (m), *16131* (3) (f) KMG.

Hansen 3141 (3) (f) PRE. *Henrici 4708* (1) (m) PRE. *Herbert 29* (4) (m) KMG. *Herman 654* (3) (m), *1523* (4) (m), *1524* (4) (f) PRE. *Humbert 9537* (2) (f) PRE.

Jacobsen 2929 (3) (m) PRE. *Jacot-Guillarmod 592* (1) (f), *9920* (2) (m) PRE. *Jarman 82* (1) (m) PRE. *Joffe 831, 942* (2) (f), *J1* (3) (f) PRE. *Jooste 104* (3) (m), *123* (3) (f), *216* (1) (f) PRE. *M. Jordaan 1135* (5) (f) PRE. *P. Jordaan CBK9* (3) (f) PRE.

Killick 4304 (1) (f) PRE. *King 69* (5) (f) PRE. *Kotze 43* (5) (m), *44* (5) (f) PRE.

Lang TRV31709 (3) (f) PRE. *Leach & Bayliss 12920, 12962* (3) (f) PRE. *Leendertz 1136, 2142, TRV11245* (3) (f) PRE. *Leighton 3112* (2) (m) PRE. *Leistner 495* (1) (m) PRE. *Le Roux 366* (3) (f) PRE. *Letty 223* (2) (f) PRE. *L.C.C. Liebenberg 4480* (3) (f), *7377* (1) (f), *8078* (2) (m) PRE. *Liebenberg S.78, S.84* (3) (m) PRE. *Louw 234* (3) (m) PRE.

MacDevette 252 (2) (f) PRE. *Macdonald 76/24, 77/148* (3) (f) KMG, PRE. *MacMurray 5942* (3) (m), *5943* (3) (f) KMG; *5980* (4) (f) KMG, PRE. *Marais 1137* (2) (f) PRE. *Marloth 557* (2) (f & m), *1009, 1329* (3) (m), *5056, 12750* (3) (f) PRE. *Mbedzi 1561* (5) (f) PRE. *McClean 265* (2) (f) PRE. *McDonald 77/121* (4) (f), *77/122* (4) (m) KMG, PRE. *McGregor Museum 5980* (4) (f) PRE. *McMurtry 2432* (5) (m) PRE. *Miller B/202* (3) (f) PRE. *Moffett 605* (1) (f) PRE. *Mogg 4788, 13209* (2) (f), *7925* (3) (f & m), *8517* (3) (m), *16922* (3) (f), *PRE43479* (5) (f) PRE. *Moore 11* (3) (f) PRE. *Morze 2005* (2) (f) PRE. *Mott 985* (3) (f) PRE. *Muir 132* (2) (f) PRE. *Muller 1206, 1505* (3) (f) PRE. *Munro P.S.11* (2) (f), *PRE2909* (5) (m) PRE. *Murray 634* (3) (f) PRE.

Nelson 29 TRV11384 (3) (f) PRE.

Oates 312 (3) (m) PRE. *O'Callaghan, Fellingham & Van Wyk 31, 186* (2) (f) PRE. *Osborne 18* (2) (m) PRE. *Owens 99, 104* (3) (f) PRE.

Pagan 1729a (3) (f) KMG. *Paterson 1001, TRV12337* (2) (f) PRE. *Pearson 1610* (3) (m) PRE. *Peeters, Gericke & Burelli 4* (3) (f) PRE. *Phalatse 17* (3) (m) PRE. *Phelan 1048* (3) (f) PRE. *J. Phillips 1175, 1370* (3) (m) PRE. *J.F.V. Phillips For.Herb.350* (2) (f) PRE. *Pillans 3492* (2) (m) PRE. *Pole Evans 1260, 2226* (3) (m), *2495, 2495(42)* (4) (f), *2496, 2496(43)* (4) (m), *3594* (5) (f), *H.15695* (3) (f), *H.18041* (2) (m) PRE. *Pole Evans & Smith 1859* (1) (f) PRE. *Potter ex Henrici 2030* (1) (m), *2031* (1) (f) PRE. *Poynton For.Herb.11990* (2) (f) PRE. *Prior PRE43495* (2) (f & m) PRE. *Prosser 1844* (3) (f) PRE.

Rauh & Schlieben 9644 (3) (f) PRE. *Rehm PRE43513* (1) (f) PRE. *Repton 616* (3) (f & m), *4525, 4562* (5) (f) PRE. *Roberts 5379* (1) (m) PRE. *Rodin 2122* (3) (f), *3062* (2) (m) PRE. *Rogers 24097* (5) (f), *26851* (2) (f), *TRV22185* (5) (f) PRE. *Romanowski 6* (2) (f) PRE. *Rose-Innes 86* (5) (f) PRE. *Ross 2117* (5) (f) PRE. *Rossouw TRV26142* (3) (f) PRE. *Rowland, Sealt, Steyn PRE26464* (4) (f) PRE. *Rudatis 1646* (2) (f) PRE.

Scharf 1140 (2) (m), *1393, 1419* (2) (f) PRE. *Scheepers 1596* (3) (f) PRE. *Schlieben 8749* (3) (f) PRE. *B. Schmidt 15* (3) (f) PRE. *E. Schmidt 330* (3) (m) PRE. *Schmitz 6850, 6851* (1) (m), *9262* (1) (f) PRE. *Schonland 1628* (3) (f) PRE. *Shearing 1204* (1) (f) PRE. *Silk 264* (3) (f) KMG. *Sim 2101, 20429* (2) (f) PRE. *C.A. Smith 440A, 440B, 942* (1) (f), *4417* (3) (f & m), *4502* (3) (f), *5452* (1) (f) PRE. *P.A. Smith 2591* (3) (f) PRE. *Smuts 1417* (3) (f) PRE. *(Mrs) J.C. Smuts PRE43492* (2) (f) PRE. *Smyth PRE43528* (2) (f) KMG, PRE. *South 671* (2) (m) PRE. *Speedy 11/22* (3) (m) PRE. *Stalmans 621* (5) (f) PRE. *Story 101, 137* (1) (f), *1057* (3) (m), *1190* (4) (f), *4585, 4635, 4877, 4981, 5277* (3) (f) PRE. *Strey 3288* (5) (f), *6536* (2) (m), *7660a, 8825, 9713* (2) (f), *9709* (2) (m), *9757* (5) (m) PRE. *Sutton 880* (5) (f), *1293* (3) (f) PRE.

Taylor 7111 (3) (m), *10219* (2) (f) PRE. *Theiler TRV12362* (5) (f) PRE. *G.C. Theron 345* (1) (m), *815* (3) (f) PRE. *G.K. Theron 1429* (5) (f) PRE. *J.J. Theron 636* (3) (m) PRE. *Thode 2801* (5) (f), *A527* (1) (f), *A861* (2) (m), *A2479* (2) (f) PRE. *Thorne PRE45409* (3) (f) PRE. *Tyson PRE3102, Herb.Marl.8541* (2) (m) PRE.

Van Breda 1147 (2) (f) PRE. *Van Dam TRV18856* (2) (f) PRE. *Van der Schijff 6733, 8026* (3) (f) PRE. *Van der Spuy 59* (3) (f) PRE. *Van Eck 1* (3) (m), *2* (4) (f) PRE. *Van Hoepen 1846* (4) (f) PRE. *Van Son TRV28805* (3) (m), *TRV28806* (3) (f), *TRV31769* (3) (m) PRE. *A.E. van Wyk 1842* (2) (f) PRE. *P. van Wyk BSA118* (3) (f), *BSA992* (5) (f) PRE. *Van Zinderen-Bakker 97* (3) (f), *997* (3) (m), *1063* (1) (f) PRE. *F. Venter 933* (2) (f), *2006* (3) (m) PRE. *H.J.T Venter 3749* (5) (m), *3750* (5) (f) PRE. *Verdoorn 1002* (1) (f), *1590* (1) (m), *1761* (3) (f), *1762* (3) (m), *PRE30042* (5) (f) PRE. *Victor 347* (2) (f), *1452* (1) (f) PRE. *A. Viljoen 69* (2) (f) PRE. *G. Viljoen 56* (5) (m) PRE. *Viviers 167* (2) (m) PRE.

Ward 1402, 2612, 7719 (5) (f), *2611, 2613, 7718* (5) (m) PRE. *Walsh PRE61373* (2) (f) PRE. *Werdermann & Oberdieck 1578* (1) (m) PRE. *West 1230* (5) (f), *1804* (5) (m) PRE. *White 5101* (2) (f), *10509* (5) (m) PRE. *Williamson 274* (5) (f) PRE. *Wilman 1244, PRE43493* (3) (m) PRE; *1728, KMG11733* (4) (m), *3319, 5990b, 6527* (3) (f) KMG; *5979, 5990, 6268, 6269* (3) (f) KMG, PRE. *Wirminghaus 289* (2) (f) PRE. *Wood Herb.Galpin3229* (2) (m) PRE.

Zambatis 669 (5) (f) PRE. *Zeyher 819* (2) (m) PRE.

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Taxonomy of the *Passerina filiformis* complex (Thymelaeaceae)

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Keywords: anatomy, new species, *Passerina*, southern Africa, taxonomy, Thymelaeaceae

ABSTRACT

Revision of the genus *Passerina* L. indicated a new delimitation of taxonomic entities within the *Passerina filiformis* L. complex. Evidence from leaf anatomy greatly assisted in the recognition of taxa. *P. filiformis* is here divided into two subspecies, namely *P. filiformis* subsp. *filiformis* and *P. filiformis* subsp. **glutinosa** (Thoday) Bredenkamp & A.E.van Wyk, and a new species, *P.* **montivagus** Bredenkamp & A.E.van Wyk, which is also described. The new taxa are geographically separated: subsp. *filiformis* ranges from Piquetberg in the north through the Cape Peninsula in the south, where it is quite common, to Attaquaskloof in the southwestern Cape; subsp. **glutinosa** occurs along the coast between Vredendal and St Helena Bay; and *P.* **montivagus** has a wide distribution from Mossel Bay and Oudtshoorn in the south through Eastern Cape and along the Great Escarpment northwards to Zimbabwe, with outliers in Tanzania.

INTRODUCTION

Passerina L., a genus of woody shrublets or shrubs, comprises about 20 species and four subspecies, all confined to southern and eastern Africa (Thoday 1924; Goldblatt & Manning 2000). With the exception of a few species growing along the Great Escarpment, most members are endemic to the Cape Floristic Region with its Mediterranean or semi-Mediterranean climate. In the most recent taxonomic revision of the genus, Thoday (1924) considered *P. filiformis* L. a variable species with a wide range, noting that plants from KwaZulu-Natal are more robust and luxuriant in growth. The purpose of the present paper is to present a taxonomic re-assessment of the *P. filiformis* complex based on evidence from epidermal structure (Bredenkamp & Van Wyk 1999, 2000), leaf anatomy (Bredenkamp & Van Wyk 2001a) and floral morphology (Bredenkamp & Van Wyk 2001b). We propose the subdivision of *P. filiformis* L. into two subspecies and describe a new species; all the new taxa are geographically separated (allopatric).

MATERIAL AND METHODS

All collections of *Passerina* in the following herbaria (acronyms according to Holmgren *et al.* 1990) were studied for taxonomy and external morphology: BM, BOL, BREM, C, GRA, K, LINN, M, MO, NBG, PR, PRE, PRU, S, SBT, TCD, UPS.

For leaf anatomy, both fresh and herbarium material were studied. Names of taxa and voucher specimens used in anatomical studies are listed in Table 1.

Light microscopy (LM) was used for general leaf anatomical as well as epidermal studies. Methods for preparation of transverse sections and for the study of cuticles are described by Bredenkamp & Van Wyk (2000).

TABLE 1.—*Passerina* specimens examined anatomically and housed at PRE

Taxon	Voucher specimens
filiformis	
subsp. *filiformis*	*Boucher 2833*; *Bredenkamp 1039*
subsp. *glutinosa*	*Schlechter 5125*; *Taylor 1542*
montivagus	*Bredenkamp 1012, 1016, 1017, 1327*; *Gillett 4537*; *Keet s.n.*; *Killick 238*; *Van Wyk & Bredenkamp 1*

Scanning electron microscopy (SEM) was used to study epidermal surface features (including epicuticular waxes) and to elucidate the structure of the cuticle (Bredenkamp & Van Wyk 2000). Transmission electron microscopy (TEM) was used to establish the structure of mucilaginous epidermal cell walls (Bredenkamp & Van Wyk 1999).

1. **Passerina filiformis** *L.*, Species plantarum: 559 (1753); Thunb.: 75 (1794); J.C.Wendl.: 18 (1798); Wikstr.: 324 (1818); Thunb.: 374 (1825); Meisn.: 562 (1857); C.H.Wright: 10 (1915); Thoday: 159 (1924); Bond & Goldblatt: 432 (1984); Hilliard & B.L.Burtt: 182 (1987); Goldblatt & J.C.Manning: 683 (2000). Type: *Passerina filiformis*, *Linnean Herbarium 504.1* (LINN, lecto.!, here designated).

Passerina phyliformis Hort. Bot. Bonarensis in Herb Zuccarinii (K, M!), err. typogr.

P. cupressina J.C.Wendl. nom. nud. Meisn.: 404 (1840); Meisn.: 563 (1857); Thoday: 159 (1924). *P. cupressoides* Steud.: 273 (1841).

P. pectinata Lodd.: 18 (1816) nom. nud. Wikstr.: 347 (1818); Meisn.: 404 (1840); Meisn.: 562 (1857); Thoday: 159 (1924).

Large rounded shrubs up to 2 m high, often lax in shade. *Stems* initially greyish tomentose, cork finely grey-brown tessellate, becoming glabrous, with conspicuous leaf scars and hair-like, whitish fibres protruding between bark fissures. *Leaves* sessile, sometimes glutinous, closely adhering to stem or spreading from stem at an angle of ± 30°; lamina narrow, almost terete, acerose or linear, transversely elliptic or cordiform in c/s, length × $^1/_2$ width (because

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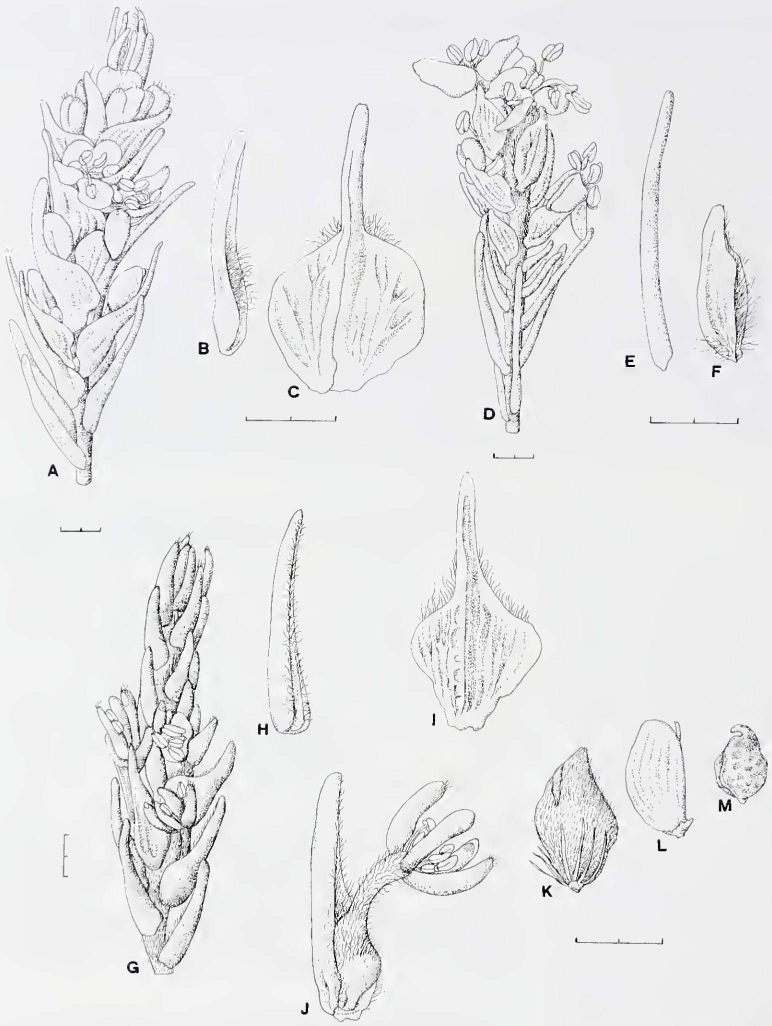

FIGURE 1.—A–C, *Passerina filiformis* subsp. *filiformis*, *Bredenkamp 1039*: A, inflorescence; B, leaf; C, bract. D–F, *P. filiformis* subsp. *glutinosa*, *Schlechter 5125*: D, inflorescence; E, leaf; F, bract. G–M, *P. montivagus*, *Bredenkamp 1327*: G, inflorescence; H, leaf; I, bract; J, flower clasped by bract; K, fruit enveloped by persistent hypanthium, fragmented at neck base; L, membranous pericarp enveloping seed, remnant of lateral style apically present; M, seed with black tegmen. Scale bars: 2.0 mm.

lamina is rolled) (4.0–)5.5–8.0(–10.0) × (0.4–)0.6–1.0 mm, tapering towards rounded apex, slightly widening or widening towards base, coriaceous, smooth, dark green to greyish green, often drying brown; adaxial groove tomentose; abaxial surface convex, glabrous; margin involute. *Inflorescences* subterminal, 10–20-flowered, composed of proliferating spikes. *Bracts* cymbiform, outside glabrous, inside setose from base to central part, ovate-acuminate to widely obovate, length × $^1/_2$ width ± 4.6–7.3 × 1.5–2.0 mm, gradually narrowing to point or narrowing abruptly into filiform point, base cuneate to widely cuneate, main vein strongly developed, often keeled, shortly extended or extending to form leaf-like point; lamina coriaceous or chartaceous; wings glabrous, membranous with distinct venation, margins glabrous or ciliate, often with few trichomes at apex adjacent to filiform point. *Flowers* glutinous or not. *Floral envelope* ± 6.0–6.5 mm long, yellow-pink during pollination, sparsely tomentose or tomentose at ovary, neck 1.5–1.7 mm long, sparsely tomentose or tomentose; outer and inner sepals with adaxial surface glabrous, apex abaxially setose; outer sepals concave obovate, inner sepals concave obovate or obovate, ± 2.2–2.5 × 1.4–1.5 mm. *Androecium*: filament of antipetalous whorl ± 1.1–1.2 mm, antisepalous whorl ± 2.2 mm; anthers ± 0.8 × 0.3 mm. *Ovary* ± 2.3–2.5 × 0.5–0.6 mm. *Fruit* enveloped by persistent, loosely arranged hypanthium fragmenting at neck base; pericarp membranous and dry. *Flowering time*: in spring when pollen is wafted away in clouds, cause of hay fever in sensitive persons (Marloth 1925). Figure 1A–F.

Leaf anatomy

Leaf structural type B: bundle sheath completely enveloping main vascular bundle, extraxylary sclerenchyma fibres enclosed in bundle sheath (Bredenkamp & Van Wyk 2001a).

Leaf outline in transverse section (t/s) cordiform to transversely elliptic. *Adaxial epidermis*: cuticular membrane (CM) ± 2 μm thick, periclinal × anticlinal cell diam. in t/s 15 × 10 μm. *Abaxial epidermis*, in surface view, glutinous or not, glabrous, CM mostly exhibiting a striate pattern, cuticle with epicuticular waxes, wax plates scarce, oblong, raised 90°, with sharp edges, usually arranged perpendicular to cell rows, epidermal cells arranged in rows, oblong, pentagonal to heptagonal in outline, 45–50 × 30 μm; CM 15–20 μm thick in t/s, pro-

nounced at junctions of epidermal cell walls, grooved in midline of joining walls, concavities and convexities present, periclinal × anticlinal cell diam. in t/s (35–)40(–45) × 45–50(–80) µm, mucilagination of mainly inner tangential cell walls often resulting in mucilage-filled cavities between remains of epidermal cells and adjacent mesophyll. *Palisade parenchyma* horseshoe-shaped, 1- or 2-layered, density 5 cells per 50 µm. *Spongy parenchyma* aerenchymatic. *Main vascular bundle* 350–420 µm thick, 780–860 µm wide, widely ovate, variously orientated in relation to mesophyll: touching palisade parenchyma abaxially (type B3), sunken into palisade parenchyma (type B4) (Figure 2A) or bordering on abaxial epidermis (type B6) (Figure 2B). *Bundle sheath* completely enveloping vascular bundle, consisting of 13–15(–27) cells. *Secondary vascular bundles* 2–4 on each side of main bundle. *Sclerenchymatous hypodermal sheath* absent. Figure 2A, B.

Two of the four *Passerina* specimens in the Linnean Herbarium are named *P. filiformis* in the handwriting of Linnaeus; these specimens are numbered 504.1 and 504.2 in Savage (1945). Number 504.2 is undoubtedly *P. paleacea* Wikstr. Thoday (1924) maintains that number 504.1 is a Clifford specimen and probably the one Linnaeus saw when he wrote the first edition of *Species plantarum* (1753). Savage (1945) added the inscription [? ex herb. Cliff.], indicating doubt as to the origin of this specimen. The first author has seen this specimen and agrees with Thoday (1924) that it matches the concept of *P. filiformis* perfectly, as it is known in the Cape Peninsula. The phrase 'Passerina foliis linearibus' in the *Species plantarum* (1753), has clearly been copied by Linnaeus from *Hortus Cliffortianus* (1738) and from Van Royen (1740). The leaves in the illustration in *Hortus Cliffortianus* are ± lanceolate and the bracts are very similar to those of *P. filiformis* subsp. *glutinosa* (Thoday) Bredenkamp & A.E.van Wyk stat. nov., which has acerose or filiform leaves. The specimen labelled *Passerina filiformis* L. in Clifford's Herbarium is sterile, lacks characteristic bracts or flowers and could possibly be *P. vulgaris* Thoday (= *P. filiformis* L. subsp. *vulgaris* Meisn.). *P. vulgaris* is the dominant *Passerina* species in the southern and southwestern Cape and is constantly confused with *P. filiformis*. Specimen 504.1 in the Linnean Herbarium, which is named *P. filifomis* by Linnaeus, is here designated as the lectotype. *Thymelaea aethiopica*, in Plukenet (1700: 180), is cited in synonymy under *P. filiformis* by Linnaeus (1753). The illustrated synonym of Breyne (1678) most probably belongs to the genus *Phylica* L. (Rhamnaceae) and that of Burman (1739) is clearly a species of *Struthiola* L. (Thymelaeaceae).

Etymology: the Latin specific epithet *filiformis* (= thread-like) obviously refers to the narrow leaves of this species. The vernacular name 'sparrow-wort' was suggested by Miller (1768) for all *Passerina* species, indicating *P. filiformis* as 'sparrow-wort with linear convex leaves'. Wendland (1798) used the German equivalent *fadenförmige Vogelkopf.* Marloth (1925) mentioned the names *kannabas* and *kaalgaar*. The following Afrikaans names appear in Smith (1966) and some of them also in Palmer & Pitman (1972) and Coates Palgrave (1977): *bakbossie, bakkersbossie, bruingonna, fyntaaibos, gannabas, gonnabas, kaalgaarbos, kaalgaring, kabelgaring, kannabas, koordehaar, taaibos, windmakersbessie, windmakersbossie.*

Key to subspecies

Branchlets and inflorescences dry; bracts widely obovate, narrowing abruptly into filiform point . . . . 1a. subsp. *filiformis*
Branchlets and inflorescences glutinous; bracts ovate-acuminate, gradually narrowing to point . . . . 1b. subsp. *glutinosa*

1a. subsp. **filiformis**

Leaves spreading from stem at angle of ± 30°; lamina almost terete, cordiform in c/s, length × $^1/_2$ width (4.0–)5.5–8.0(–10.0) × 0.6–1.0 mm, slightly widening towards base, dark green to greyish green. *Inflorescences* not glutinous. *Bracts* widely obovate, length × $^1/_2$ width ± 7.3 × 2.0 mm, base widely cuneate, main vein strongly developed, often keeled, extending to form a leaf-like point; lamina chartaceous; margins glabrous, often with a few trichomes at apex adjacent to filiform point. *Flowers* not glutinous. *Floral envelope* ± 6.0 mm long, tomentose at ovary, neck 1.7 mm long, tomentose, outer sepals concave, obovate, inner sepals obovate. Figure 1A–C.

Leaf anatomy

Leaf outline in t/s transversely elliptic to cordiform. *Adaxial epidermis*: CM ± 2 µm thick; periclinal × anticlinal cell diam. in t/s 15 × 10 µm. *Abaxial epidermis*, in surface view, not glutinous, cells oblong, 45–50 × 30 µm; CM 15–20 µm thick in t/s, periclinal × anticlinal cell diam. (35–)40(–45) × 45–50(–80) µm. *Palisade parenchyma* in 1 or 2 layers of elongated cells. *Main vascular bundle* 350–420 µm thick, 780–860 µm wide, touching palisade parenchyma abaxially (type B3) or sunken into palisade parenchyma (type B4) (Figure 2A). *Bundle sheath* consisting of 13–15 cells. *Secondary vascular bundles* 3 or 4 on each side of main bundle.

Diagnostic characters and relationships: subsp. *filiformis* is morphologically distinguished by the almost terete, adaxially grooved, acerose or linear leaves, the cymbiform, widely obovate floral bracts, which abruptly narrow to a filiform point (Figure 1A–C), and by the long (± 1.7 mm) hypanthium neck. As both subsp. *filiformis* and *P. vulgaris* occur in the Cape Peninsula, they are often confused. Diagnostic characters of *P. vulgaris* include linear to narrowly lanceolate leaves, the diamond-shaped bracts and leaves with a hypodermal sclerenchymatous sheath (Bredenkamp & Van Wyk 2001a). Some specimens of subsp. *filiformis* with incurved, tapering leaves and the necks of the hypanthium exserted from the clasping, veined bracts, could be mistaken for *P. falcifolia*. The apical beard on the young leaves and outer sepals and the glabrous inner sides of the bracts are reliable diagnostic characters, distinguishing the subsp. *filiformis* from *P. falcifolia*.

Etymology and uses: according to Van Wyk & Gericke (2000) the name *bakkerbos* commemorates an era in the Cape when the official licensed bakers used the branches

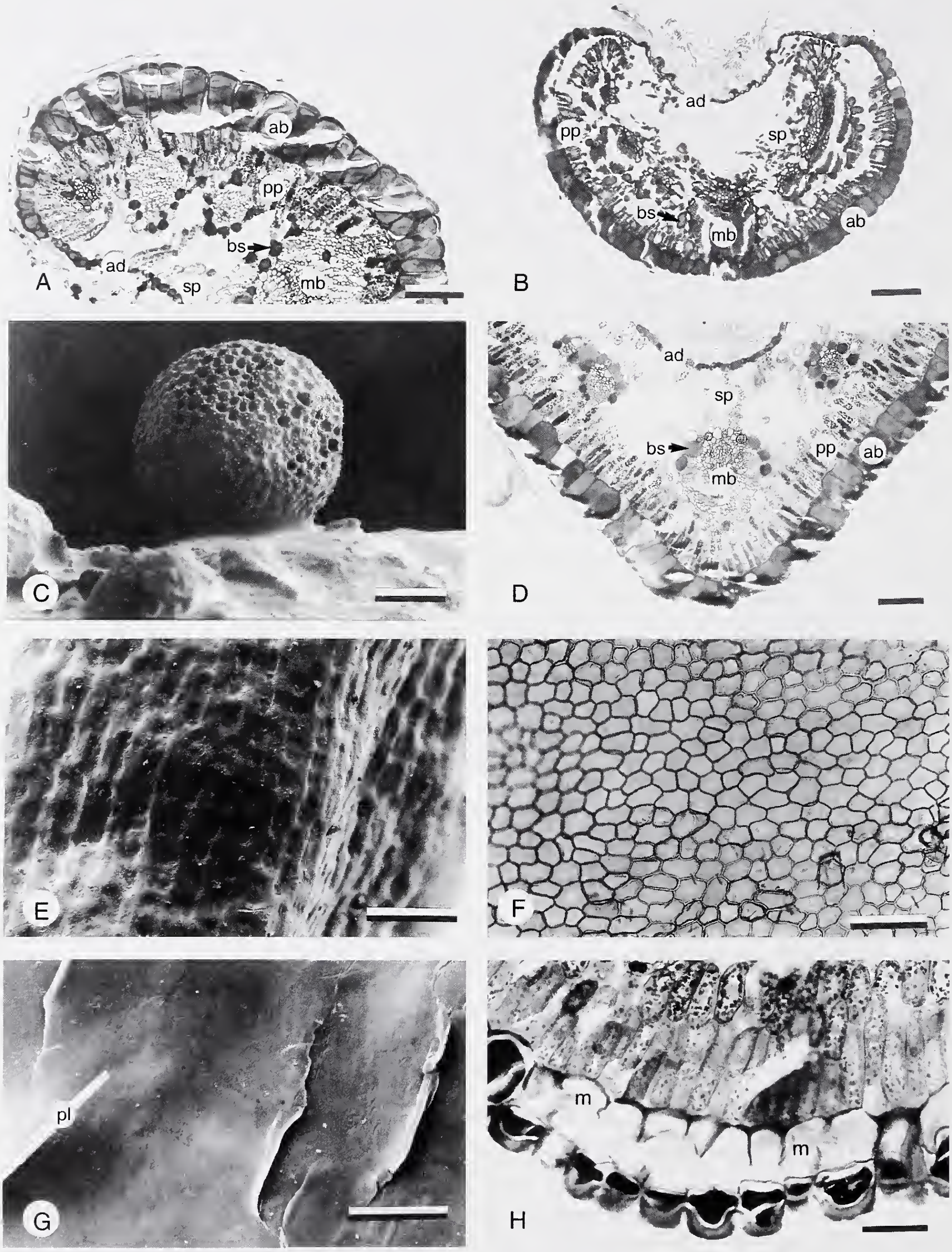

FIGURE 2.—LM photographs and SEM micrographs showing leaf anatomy and epidermal structure of selected species in *Passerina*: A, *P. filiformis* subsp. *filiformis*, *Bredenkamp 1039*, leaf in t/s, illustrating leaf structural type B4. B, C, *P. filiformis* subsp. *glutinosa*, *Schlechter 5125*: B, leaf in t/s, from rehydrated herbarium material, illustrating leaf structural type B6; C, glutinous substance sticking pollen grain to leaf surface. D, *P. montivagus*, *Bredenkamp 1016*, leaf in t/s illustrating leaf structural type C. E–H, abaxial epidermis in *P. montivagus*: E, in surface view, with cells arranged in rows, *Bredenkamp 1012*; F, epidermal cells oblong, pentagonal to heptagonal, *Bredenkamp 1016*; G, upright epicuticular wax platelets, *Bredenkamp 1016*. H, mucilagination of inner tangential cell walls, resulting in mucilage-filled cavities, *Killick 238*. ad, adaxial epidermis; ab, abaxial epidermis; bs, bundle sheath; m, mucilage; mb, median vascular bundle; pl, epicuticular wax plates; pp, palisade parenchyma; sp, spongy parenchyma. Scale bars: A, B, D–F, H, 100 µm; C, G, 10 µm.

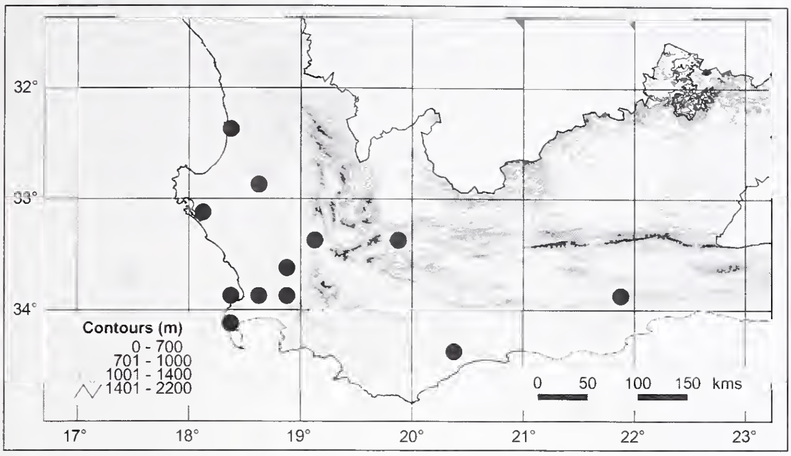

FIGURE 3.—Known distribution of *P. filiformis* subsp. *filiformis*.

and leaves of this plant to heat their ovens. The plants used at that time were clearly the subsp. *filiformis*. When ignited, plants of subsp. *filiformis* disappear in a blaze of hot flame owing to a waxy secretion on the leaves (Smith 1966). The plants were formerly used for heating up stoves. Today it is quite scarce in the vicinity of Cape Town, because of the commercial use of this once abundant resource. At maturity, these plants are quite ornamental and have been cultivated in Britain and Europe since the time of Linnaeus. Plants of the subsp. *filiformis* are soboliferous and vigorous resprouters. They are well adapted to the Cape climate and would be suitable for reclamation plantings in areas where alien invasive vegetation has been cleared. The tough bark was used by indigenous peoples instead of twine (Marloth 1925). According to Laidler (1928) a decoction of this plant is used by the rural people of the Cape for shooting pains.

Distribution and ecology: *P. filiformis* subsp. *filiformis* is common in the Cape Peninsula and is distributed from Piquetberg, across the Hex River Mountains, to Attaquaskloof in the southwestern Cape. It grows in rocky areas, mostly on south-facing mountain slopes and on sandy plains, such as the Rietvallei and Stellenbosch Flats. Figure 3.

Conservation status: Least Concern (LC) (IUCN Species Survival Commission 2000).

1b. subsp. **glutinosa** (*Thoday*) *Bredenkamp & A.E. van Wyk*, stat. nov.

TYPE.—Malmesbury Div., around Langeenheid Station, *Thoday 215* (BOL!; NBG, lecto.!, here designated).

P. filiformis L. var. *glutinosa* Thoday in Kew Bulletin 4: 160 (1924).

Leaves glutinous, closely adhering to stem or spreading at angle of ± 30°; lamina narrow, acerose or linear, transversely elliptic in c/s, length × $^1/_2$ width ± 7.0 × 0.4 mm, tapering towards rounded apex, widening towards base, dark green, drying brown. *Inflorescences* glutinous, somewhat longer than in typical subspecies. *Bracts* ovate-acuminate, gradually narrowing to point, length × $^1/_2$ width ± 4.6 × 1.5 mm, base cuneate, main vein strongly developed; lamina coriaceous; wings membranous, with distinct venation; margins often ciliate. *Flowers* glutinous. *Floral envelope* ± 6.5 mm long, sparsely tomentose at ovary, neck 1.5 mm long, sparsely tomentose, outer and inner sepal lobes concave-obovate. Figure 1D–F.

Thoday 215 in NBG was chosen as lectotype because of the longer inflorescences and the conspicuously glutinous, narrow leaves. Duplicates of the syntype of var. *glutinosa*, *Schlechter 5125*, from BM, C, K, MO, PRE and S were seen. Although these specimens agree closely with the concept of var. *glutinosa* (Thoday 1924), the glutinous character is not evident in the dried specimens.

Leaf anatomy

Leaf outline in t/s transversely elliptic. *Adaxial epidermis* with CM ± 2 μm thick; periclinal × anticlinal cell diam. in t/s 15 × 10 μm. *Abaxial epidermis*, in surface view, glutinous (Figure 2C), cells slightly oblong, 50 × 30 μm; CM 15 μm thick in t/s, periclinal × anticlinal cell diam. 40 × 55 μm. *Palisade parenchyma* in 2 layers of elongated cells. *Main vascular bundle* ± 400 μm thick, ± 820 μm wide, sunken into palisade parenchyma abaxially (type B4) or bordering on abaxial epidermis (type B6) (Figure 2B). *Bundle sheath* consisting of ± 27 cells, adaxially radiating outwards, abaxially tanniniferous, specializing into collenchyma in contact with abaxial epidermis. *Secondary vascular bundles* 2 or 3 on each side of main bundle.

Distribution and ecology: subsp. *glutinosa* occurs in the Strandveld (Acocks 1988), from Doring Bay in the north to St Helena Bay in the south. The vegetation surrounding Doring Bay is described as Strandveld Succulent Karoo by Hoffman (1998). The area is characterized by deep, calcareous, coastal Quaternary sands and generally low rainfall. St Helena Bay is situated in the Sand Plain Fynbos (Rebelo 1998). This part of the range has a Mediterranean-type climate with summer drought and deep acid sands. Sand Plain Fynbos is a highly endangered vegetation type because of urbanization and the impact of alien invasive plant species (Rebelo 1998). Figure 4.

Conservation status: Near Threatened (NT) (IUCN Species Survival Commission 2000).

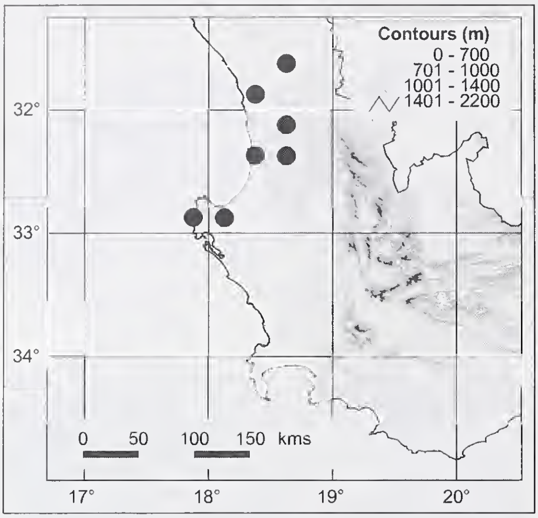

FIGURE 4.—Known distribution of *P. filiformis* subsp. *glutinosa*.

2. **Passerina montivagus** *Bredenkamp & A.E.van Wyk*, sp. nov., a *P. filiforme* L. habitu robustiore et luxuriantiore distinguenda. *Folia* cymbiformia, secus nervum medium plicata, lanceolata, ad apicem rotundatum decrescentia, basi expansa. *Bracteae* cymbiformes, ovatae ad obovatae, extra glabrae, intra basaliter setosae, in carinam longam, fere cylindricam, adaxialiter sulcatam, leviter incurvam gradatim decrescentes, basi cuneatae, coriaceae, sed lateris vel alis chartaceis, plus minusve tricostatis, marginibus trichomatibus conspicuis crassis serialibus secus dimidium distalem obsitis.

TYPE.—KwaZulu-Natal, 2930 (Pietermaritzburg): hills above Pinetown, 2400 ft, (–DD), 3 December 1891, *J.M.Wood in PRE49409* (PRE!, holo.; MO!, iso.).

Passerina filiformis L.: 559 (1753) pro parte, excluding type; Thunb.: 75 (1794); Wikstr.: 324 (1818); Thunb.: 374 (1825); Meisn.: 562 (1857); C.H.Wright: 10 (1915); Thoday: 159 (1924); Bond & Goldblatt: 432 (1984); Hilliard & B.L.Burtt: 182 (1987); Goldblatt & J.C.Manning: 683 (2000).

Low, spreading shrub 1(–2) m high, vigorous resprouter. *Stems* initially greyish tomentose, cork fissuring lengthwise into fine, dark grey, tomentose strips, older branchlets glabrous, with conspicuous leaf scars. *Leaves* sessile, spreading from stem at angle of ± 45°; main vein sturdy; lamina cymbiform, folded along main vein, lanceolate, often slightly falcate, length × $^1/_2$ width 5.6–7.0(–8.0) × 0.7–1.0 mm, tapering towards rounded apex, expanded at base, ciliate, coriaceous, smooth, greyish green; adaxial surface tomentose; abaxial surface glabrous; margin involute. *Inflorescences* subterminal, 10–20-flowered, composed of proliferating spikes, common. *Bracts* cymbiform, outside glabrous, inside basally setose; lamina coriaceous, ovate to obovate, length × $^1/_2$ width ± 6.3 × 1.6 mm, narrowing gradually into sturdy, leaf-like point of extended main vein, base cuneate; wings chartaceous ± 3-ribbed, obscurely veined, greyish green, margins conspicuously lined with strong white trichomes along distal half, often reaching up to apex. *Floral envelope* ± 6.6 mm long, yellow-pink during pollination, tomentose at upper half of ovary, neck tomentose ± 2.3 mm long; adaxial surface of outer and inner sepals glabrous, apex setose abaxially; outer sepals cymbiform, inner sepals obovate, ± 2.1 × 1.3 mm. *Androecium*: filament of antipetalous whorl ± 0.8 mm long, antisepalous whorl ± 1.7 mm long; anthers ± 0.8 × 0.3 mm. *Ovary* ± 2.2 × 0.7 mm. *Fruit* enveloped by persistent, loosely arranged hypanthium fragmented at neck base; pericarp membranous and dry. Figure 1G–M.

Thoday (1924) noted that plants named *P. filiformis* in KwaZulu-Natal are more robust and luxuriant than those from Western Cape. *Wood s.n.* from Pinetown was chosen as the holotype of *P. montivagus* as it is a good representation of the new taxon and was determined and cited by Thoday (1924).

Leaf anatomy

Leaf structural type C: bundle sheath capping main vascular bundle adaxially, ± absent abaxially, extraxylary sclerenchyma fibres not enclosed in bundle sheath, main vascular bundle bordering on palisade parenchyma, extraxylary sclerenchyma fibres fitting into V-shaped palisade parenchyma (Bredenkamp & Van Wyk 2001a).

Leaf outline in t/s carinate. *Adaxial epidermis*: CM ± 2 µm thick, periclinal × anticlinal cell diam. in t/s 25 × 15 µm. *Abaxial epidermis*, in surface view: cuticle with epicuticular waxes, wax plates scarce, ± perpendicular to cell rows, oblong, raised 90°, with sharp edges (Figure 2G), CM mostly exhibiting a striate pattern, epidermal cells arranged in rows (Figure 2E), oblong, pentagonal to heptagonal (Figure 2F), 30–55 × 25–35 µm; CM ± 20 µm thick in t/s, pronounced at junctions of epidermal cell walls, grooved in midline of joining walls, concavities and convexities present, periclinal × anticlinal cell diam. (22.5–)30.0(–35.0) × (40–)55(–90) µm, mucilagination of mainly inner tangential cell walls often resulting in mucilage-filled cavities between remains of epidermal cells and adjacent mesophyll (Figure 2H). *Palisade parenchyma* V-shaped, in 2 layers of elongated cells, density 3 or 4 cells per 50 µm. *Spongy parenchyma* aerenchymatic. *Bundle sheath* an adaxial cap of ± 21 cells, rounded. *Main vascular bundle* (400–)560–630 (–700) µm thick, (820–)980–1180(–1280) µm wide, obovate, bordering on and fitting into the V-shaped palisade parenchyma (type C) (Figure 2D). *Extraxylary sclerenchyma fibres* not enclosed in bundle sheath. *Secondary vascular bundles* 3 or 4 on each side of main bundle. *Sclerenchymatous hypodermal sheath* absent.

Diagnostic characters and relationships: *Passerina montivagus* is easily distinguished from *P. filiformis* by its more robust and luxuriant habit. Furthermore, for some distance below the inflorescences, the foliage leaves are expanded at the base and the bracts are ovate to obovate, narrowing gradually into a sturdy, leaf-like point, with margins along their distal half conspicuously fringed by strong white trichomes. *P. montivagus* could also be confused with *P. falcifolia*, but it is distinguished from the latter by the apical beard on the young leaves

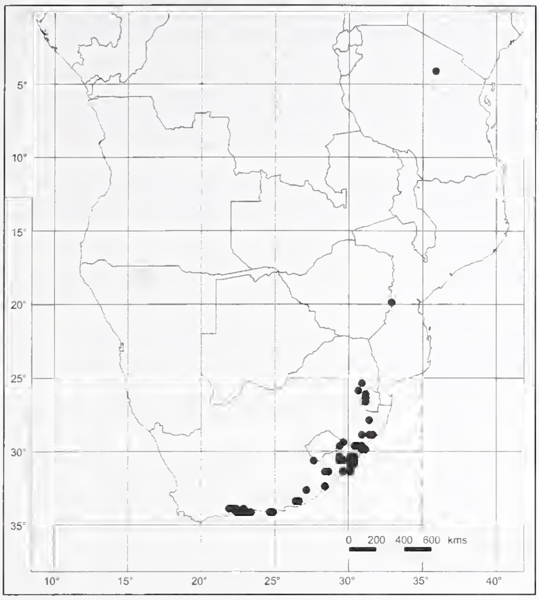

FIGURE 5.—Known distribution of *P. montivagus*.

and outer sepals and by the adaxial surfaces of the bracts, which are basally setose with glabrous wings.

Etymology: the specific epithet is a compound of the Latin *montanus* (= pertaining to mountains) and *vagus* (= in several directions), referring to the distribution of this species. Von Breitenbach *et al*. (2001) uses the names brown gonna (English), *bruingonna* (Afrikaans) and *umwele olumcane* (Zulu) for *P. filiformis* in the wide sense, but these names are most appropriate for *P. montivagus* because of its wide distribution.

Distribution and ecology: *Passerina montivagus* has a wide distribution, from Mossel Bay and Oudtshoorn in Western Cape northwards mainly along the Great Escarpment to KwaZulu-Natal, Swaziland, Mpumalanga, Northern Province, Mozambique and Zimbabwe. *Polhill & Paolo 2372*, from Tanzania, represents an extreme form of this taxon, as the bracts are smaller and almost diamond-shaped. The most southwesterly distribution of this species is in the southern Cape, a region transitional between winter and summer rainfall. However, over most of its range, the species receives summer rainfall. Because of its wide distribution, especially along the Great Escarpment, *P. montivagus* is adapted to a variety of habitats, with relatively high rainfall. It is often found along forest margins in the ecotonal zone between Afromontane forest and grassland. It has been recorded from rocky mountain peaks and slopes, river valleys, gorges and among riverside rocks. In coastal regions, it grows on hills and often borders small tributaries of streams flowing to the sea. Figure 5.

Story (1952) reported that *P. montivagus* (= *P. filiformis*) dominated the western half of a small plateau north of the Mount McDonald beacon in the Keiskammahoek District. The plants were not browsed by stock although the plateau was heavily grazed. He regarded the species as 'useless' and advised that it should be eradicated by hand, as it was not dense enough to burn without additional fuel. This Fynbos species, distributed along the Great Escarpment has not been reported as undesirable or invasive and is currently not regarded as a threat, although it might be a dominant species in restricted areas.

Conservation status: Least Concern (LC) (IUCN Species Survival Commission 2000).

SPECIMENS EXAMINED

Abbott 43, 308 (2) PRE. *Acocks 11549* (2) PRE; *19671* (1b) K, M, NBG, PRE; *24062* (1b) PRE; *890, 5174, 5754* (1a) S. *Andraea 1165* (1a) NBG, PRE. *Auferweg 850* (1a) PR.

Barker 5795, 8095 (1a) MO, NBG. *Bolus 2440* (2) BOL, K; *2925* (1a) BOL, K. *Botha 1445* (2) PRE. *Boucher 2833* (1b) PRE. *Bredenkamp 1012, 1015* (2) PRE; *1016, 1017, 1327, 1359, 1360* (2) PRE; *1039* (1a) PRE. *Bremer 317* (2) PRE, S. *Buchenau s.n.* (1a) BREM. *Buitendag 712* (2) NBG, PRE. *Burchel 66, 276, 6544* (1a) K. *Burmeister s.n.* (1a) SBT.

Cheadle & Wells 668 (2) M, PRE. *Compton 11762, 14827* (1a) NBG; *15888* (1b) NBG; *25157* (2) NBG; *26157, 29473* (2) NBG, PRE.

Dlamini s.n. (2) NBG, PRE. *Drège s.n.* (1a) K.

Ecklon s.n. (1a) PR. *Edwards 820* (2) PRE. *Esterhuysen 26437, 34096, 35680* (1a) BOL, MO, M, S.

Forbes & Obermeyer 58 (2) PRE. *Fourcade 3473* (2) NBG; *4809* (2) BOL.

Galpin 11016 (2) PRE. *Garthside 17* (1a) K. *Gerstner 1705, 9089* (2) PRE. *Gerrard 1478* (1a) BM, TCD, K. *Gill s.n.* (1a) K. *Gillett 4537* (2) BOL, PRE. *Goodier & Phipps 270* (2) MO. *Goodier 637* (2) BM, M, PRE. *Grant 1* (1a) C. *Hardy s.n.* (1a) K, S. *Herb. Linairiaro* (1a) PR. *Herb. Regium Monacense s.n.* (1a) M. *Herb. Rofski* (1a) PR. *Herb Zuccarinii s.n.* (1a) M. *Hilliard & Burtt 14463* (2) PRE; *14654* (2) K; *Hilliard & Burtt 15671* (2) N, PRE, S; *Hilliard & Burtt 18772A* (2) K, S. *Hugo 2019* (2) PRE; *2086* (2) NBG, PRE. *Huntley 612* (2) MO, PRE. *Hutchinson 258* (1a) PRE; *1298* (2) PRE.

Joffe 576 (2) TCD, PRE.

Keet s.n. (2) NBG, PRE. *Killick 238, 3469* (2) PRE. *Krebs 282* (1a) MO. *Kutzelman's Herbarium, Prague* (1a) PR.

Lehman 1891 (1a) C. *Lewis 4064, s.n.* (2) NBG. *Lundberg s.n.* (1a) S.

MacOwen 16388 (2) BM; *s.n.* (2) MO. *Mautell & Vassilatos 32* (2) PRE. *McKinnon 32* (1a) NBG. *Medical Soc. Univ.* (1a) K. *Meebold 15156, 15157* (2) M. *Mogg 13350* (2) K, PRE; *5206, 13397, 38026*, (2) PRE. *Morris 441* (2) NBG. *Moss 5643, T10* (1a) BM. *Mund & Maire s.n.* (1a) K. *Museum Bot. Hauniense* (1a) C. *Niven & Lanbert s.n.* (1a) S.

Pappe s.n. (1a) NBG. *Pedro & Pedergao 7310* (2) BOL. *Pegler 1273* (2) BOL, GRA, NBG, PRE. *Penther 1912, s.n.* (1a) S, WU; *1919* (2) M, S. *Phillipson 1200* (2) MO, PRE. *Polhill & Paolo 2372* (2) PRE. *Prior s.n.* (1a) K.

Rob & Fries 3393, 3396–3399 (1a) UPS, S. *Roberts 66, s.n.* (2) S. *Rogers 16701B* (1a) PRE. *Rudatis 1204* (2) BM, PR, S.

Schlechter 5125 (1b) BM, C, K, MO, PRE, S. *Schmidt 568* (1a) M. *Sidey 3862 (2)* PRE, S. *Sikhakhane 524* (2) PRE. *Sparrman s.n.* (1a) S. *Story 3765* (2) GRA, PRE. *Strey 7112, 11363, 11364* (2) PRE; *Strey 9321* (2) PRE, S.

Talbot s.n. (1a) K. *Taylor 1542* (1b) NBG, PRE. *Thoday 215* (1b) BOL, NBG. *Thode 4657* (2) NBG. *Thom 553, 577* (1a) K. *Thompson 41* (1b) NBG, S; *801* (1b) NBG PRE. *Trinity College s.n.* (1a) TCD. *Tyson 1287* (2) MO, NBG; *2621* (2) NBG.

Van der Merwe 1101 (1a) PRE. *Van Wyk 2622* (2) PRE, PRU, M; *5332, BSA2586* (2) PRE, PRU. *Van Wyk & Bredenkamp 1* (2) PRE, PRU. *Van Wyk & Matthews 77719* (2) K, PRU. *Victor 556* (2) PRE. *Vincent & Wearne 4* (2) PRE.

Wall 1060 (1a) S. *Ward 8832* (2) N, PRE; *10669* (2) PRE. *Wells 1809* (2) MO. *Wolley-Dod, 3103* (1a) K. *Wood 1182* (2) BOL; *8938* (2) MO; *s.n.* (2) MO, PRE. *Worsdell s.n.* (1a) K. *Wright s.n.* (1a) MO. *Without collector*: *K692* (1a).

Cultivated: *Hort. Herb. Pallas* (1a) BM; *Hort. Prague* (1a) PR; *Vinaf s.n.* (1a) PR.

ACKNOWLEDGEMENTS

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The genus *Erica* (Ericaceae) in southern Africa: taxonomic notes 1

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Keywords: *Erica* L., nomenclature, southern Africa, taxonomy

ABSTRACT

This is the first in a series of notes on the southern African species of *Erica* L. which are currently recognized. Brief synonymy citing only the important revisions and synonyms is given, as well as comments on the status and diagnostic characters of each species. One new species, *E.* **petrusiana** E.G.H.Oliv. & I.M.Oliv. and 14 new subspecies are described, and 11 species are reduced to subspecific status. Where necessary drawings of important features and variations are given. Part 1 covers the first 35 species (Sections 1–3).

INTRODUCTION

The last revision of the genus *Erica* L. covering the species in southern Africa was undertaken by Dulfer (1965) and published as a brief conspectus—excluding descriptions and with very little or no discussion about problems of delimitation and the decisions he took. All of this was based almost exclusively on the very small collection of *Erica* housed in the Natural History Museum in Vienna (W), in many cases with species represented by only one or two specimens. He had only a few small loans from the Bolus Herbarium (BOL) and the Royal Botanic Gardens, Kew (K), having been refused large loans. His work was based on that of Guthrie & Bolus in *Flora capensis* (1905) and included the 220 species described since that publication. We estimate that he had far less material on which to base his decisions than did Guthrie & Bolus, who also consulted the large collections at Kew and the Natural History Museum, London (BM) and also at Trinity College, Dublin (TCD). Bolus also consulted the important Ericaceae collections in Berlin, which, except for the Willdenow herbarium, were totally destroyed during World War II. Fortunately he was allowed to remove a few flowers from several of the types and these are in BOL.

Dulfer's work is valuable in that he spent much time checking the synonymy and old references that Guthrie & Bolus had put together. This remains a much used source of reference in our work on *Erica*. Since Dulfer's revision, another 63 species have been added, and all the species formerly included under the 23 minor genera have also been added, with the relegation of these genera to synonymy under *Erica* (Oliver 1988, 1993a, 1993b, 2000). The number of species in the genus currently stands at 765 in the area covered by the *Flora of southern Africa*. The number of specimens located in the two Cape herbaria, Bolus Herbarium (BOL) and the Compton Herbarium (NBG), which now includes the old South African Museum Herbarium (SAM) and Government Herbarium, Stellenbosch (STE), greatly increases the amount of material that exhibits variation, compared to that which was available for Guthrie & Bolus and considerably more so in the case of Dulfer.

Having studied the genus in the herbarium and in the field for 42 years (EGHO) and 15 years (IMO) respectively, we are in a position to update the species concepts currently recognized in the literature (Dulfer 1965; Oliver & Van Wyk 1993), and to publish our concepts which are incorporated as curatorial practice in the Compton Herbarium (NBG).

It has been decided to produce a series of taxonomic notes on the species following the short format used by Dulfer, but with short to detailed explanations of variations, of problems with delimitation and of new delimitation of some taxa. Where necessary illustrations of the variable taxa have been included. We have followed the numbered order started by Guthrie & Bolus (1905) and adapted by Dulfer (1965) and then by ourselves in the Compton Herbarium. This system follows the sectional arrangement used by Guthrie & Bolus in which the genus is divided into 43 sections based on the earlier work of Bentham (1839). These sections were an attempt to group the species into supposedly related assemblages. In some cases this is clearly the case, but in others there are no close relationships and species are, in our opinion, sometimes widely separated from their nearest relatives. An example is a species which was described twice by Guthrie & Bolus (1905), firstly as *E. auriculata*, which is no. 135, and secondly as E. *greyii*, which is no. 338.

This sectional/species arrangement is used here for want of a better, natural system which is as yet not forthcoming. The available morphological characters are not sufficiently adequate for this purpose due to the high degree of homoplasy present within the genus. To attempt to resolve this impasse, a study is to be undertaken into the molecular relationships of some 300 species in collaboration with overseas researchers to try to ascertain the basic clades within the genus and to couple this with an analysis of morphological characters. These results should give a good indication as to which the important morphological characters are in a reassessment of the genus at the level of subgenus and section.

In a few cases the species have not been fully resolved and we are forced to list these in complexes under the oldest name with pointers towards the problems that need to be resolved through more detailed fieldwork and molecular studies.

The genus *Erica* is by far the largest represented in the Cape Flora and it is, in our opinion, clearly still evolving

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actively. There are many species which are isolated in their relationships, and these one may regard as palaeoendemics, whereas there are many that form extremely complicated complexes that currently, and perhaps always will, defy satisfactory resolution.

To date, the only subspecific category that has been used in the main revisions is that of variety (varietas). With the current trend to drop that category, we have resorted to recognizing worthy subspecific groupings as subspecies, especially when there is, in addition to some morphological disjunction, also a disjunction in distribution, ecology or postulated pollination biology. In other cases we have refrained from a proliferation of subspecies and have resorted to listing unnamed variants which reflect what we believe are low level groupings that have been noted by us.

The concentration of so many species in the Cape Floral Region is shown in counts we have done. Often we have found four species growing in one square metre with the highest count thus far obtained being seven, or, in one case, four species in a quarter square metre—all not closely related species. In a number of cases the disjunctions between taxa can occur over very short distances with variants being confined to relatively small areas.

With such a large genus—currently 760 species in southern Africa, we are forced to publish this review in a series of parts covering a varying number of species per part depending on the complexity of the species and the species complexes in order to provide data on species delimitation soon, rather than wait many years for a complete coverage of all 680 capsular species in one publication. The 84 indehiscent fruited species have recently been dealt with in detail (Oliver 2000).

NOTE 1: in the numbering system the whole numbers for the species are those that were originally allocated by Guthrie & Bolus (1905). The species described since then until 1965 were placed by Dulfer nearest their supposedly nearest ally as a & b numbers. These we have altered to decimal notation since we use the a/b notation for subspecies. Species described since Dulfer's 1965 revision have been placed by us in their postulated alliances. Species we recognize are printed in bold Roman type. Those that are reduced to synonymy, or that we regard as cultivated forms, or dubious, are printed in bold italics.

NOTE 2: the inclusion under the synonymy of citations of publications additional to the original one, is restricted to the most important revisions of the genus. For all other citations and more detailed synonymy, reference should be made to Guthrie & Bolus (1905) and to Dulfer (1965).

NOTE 3: in the case of citations involving the two works of Andrews, *Coloured engravings of heaths* (1794–?1830) and *The Heathery* (1804–1812), the relevant work has to be cited in full in each instance, due to the considerable overlapping of publication dates (see Cleevely & Oliver 2002), and cannot be cross-referenced in the references.

ERICA COCCINEA COMPLEX

This complex, consisting of *E. coccinea*, *E. melastoma*, *E. intermedia* and *E. monadelphia*, is characterized by an enlarged petaloid bract and bracteoles adpressed to the calyx, long, attenuated, well-exserted anthers with rounded apices and basal attachment, the often flap-like placenta with a naked abaxial zone, shiny smooth seeds (not alveolate or reticulate) and leaves with a large sclerenchyma bundle on either side of the sulcus—these visible as white stripes in fresh or pressed material.

The inflorescence consists of 3-nate flowers, except in *E. melastoma* where they are borne singly.

The '*coccinea*' complex's nearest relatives are the species belonging to the small-flowered *E. imbricata* complex (no. 369) and not to any of the other large-flowered species, e.g. *E. plukenetii*, where similarities are the result of convergent evolution in pollination syndromes. It is at times difficult to differentiate between the various species, especially in the '*imbricata-placentiflora*' complex which has evolved numerous variants and in some cases these are sympatric, thus adding to the confusion. There could very well be a case for considering hybridization between some of these variants.

These two complexes cover a wide range of flower sizes from a large tubular corolla ± 20 mm long, to a small globose one ± 2 mm long. The pollination syndromes vary from bird pollination in the large-flowered species to insect and wind pollination in the small-flowered species.

Erica banksii is very similar to members of this complex, but lacks the distinctive sclerenchyma bundles in the leaves, and the anthers have the filaments attached more or less dorsally.

1. **E. coccinea** *L.*, Species plantarum edn 1, 1: 355 (1753); Salter: 633 (1951) p.p.; Dulfer: 28 (1965) p.p. Lectotype: Seba: t. 21, fig. 4 (1735), selected here by Oliver, Jarvis & Cafferty.

Note: a paper covering the typification of all Linnaean names of Cape *Erica* spp. is in preparation by Oliver, Jarvis & Cafferty.

Diagnostic features: corolla tubular, ± 16–22 mm long; bract, bracteoles and sepals with long narrow sulcus; anthers far exserted; leaves recurved.

1a. subsp. **coccinea**

E. petiveri L.: 10, t. 50 (1770); Benth.: 621 (1839); Guthrie & Bolus: 47 (1905). Lectotype: L., t. 50, selected here by Oliver, Jarvis & Cafferty, in prep.

E. sebana Donn: 45 (1796) nom. nud., et auct. mult.

E. petiveri var. *pubescens* Bolus: 47 (1905); *E. coccinea* var. *pubescens* (Bolus) Dulfer: 29 (1965). Type: Stellenbosch Div., Lowry's Pass, *Burchell 8246* (K!); Hottentots Holland *Niven 129* (K!); Caledon Div., Houw Hoek, *Burchell 8130* (K!); Div.?, *Bolus 8036* (BOL!).

Illustrations: Baker & Oliver: t. 1, 1–7 (1967); Schumann & Kirsten: 35, t. 2 & 37, t. 2 (1992); Oliver & Oliver: t. 2 (2000).

Diagnostic features: leaves small, closely packed and recurved; flowers 3-nate on ends of short, leafy, side branches, red, orange, yellow or green and usually unicoloured (Figure 1A_1, A_2).

A yellow-flowered variant with long narrow sepals which has a dark corolla mouth, occurs in the Bredasdorp to Gansbaai area.

The typical subspecies is the common and widespread taxon in this species occurring from the Cederberg to the Cape Peninsula and eastwards as far as the Kammanassie Mountains.

Vouchers: *Balfour s.n.* (MO!, NBG!); *Bolus 6758* (BOL!, NBG!); *Compton 23683* (NBG!, S!); *Johnson 304* (K!, NBG!); *Lewis 5300*

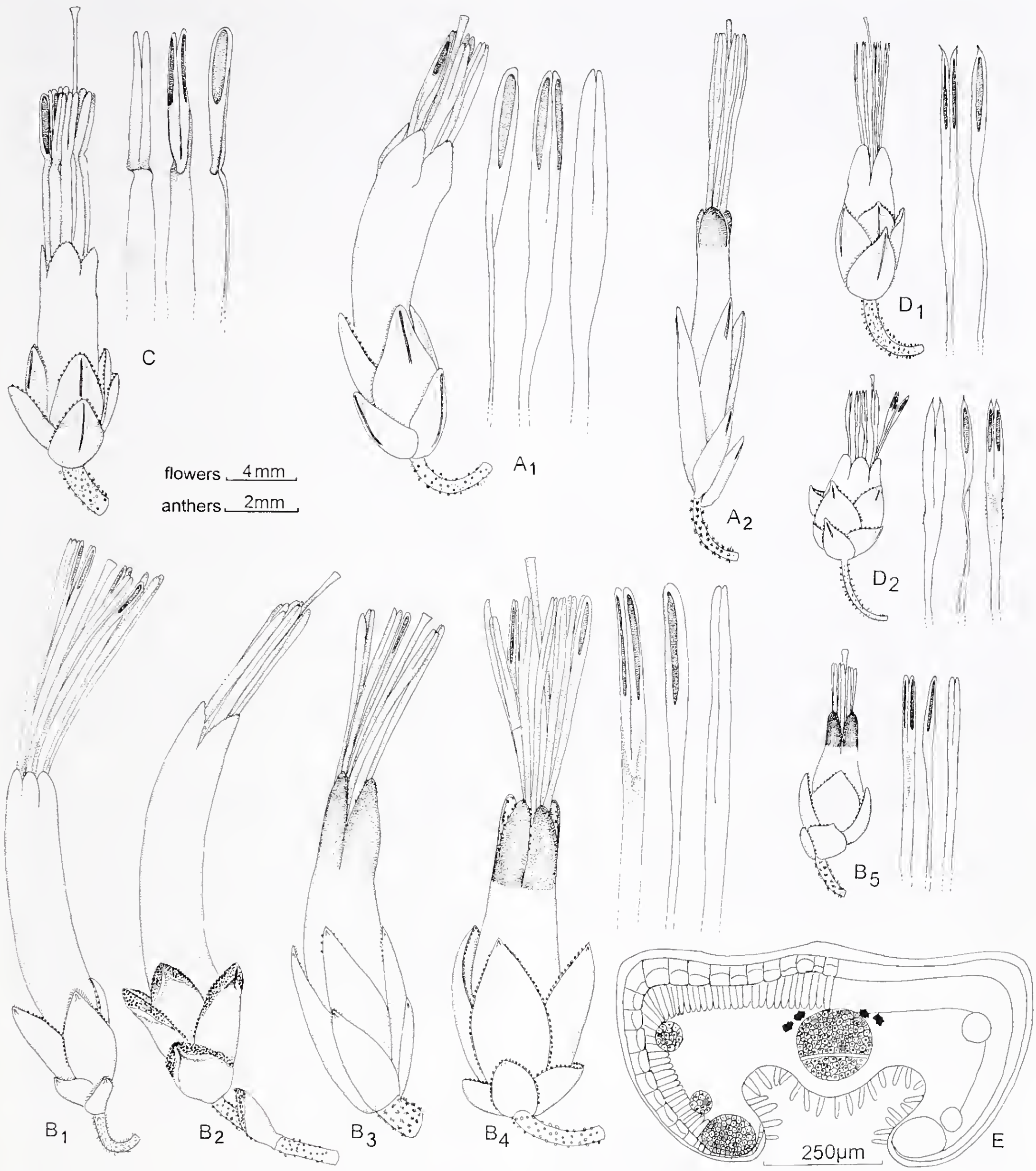

FIGURE 1.—*Erica coccinea* complex: flowers and anthers. A_1, A_2, *E. coccinea* subsp. *coccinea*: A_1, *Baker 42*, Constantiaberg; A_2, *Baker 2014*, Elim. B_1–B_4, *E. melastoma* subsp. *melastoma*: B_1, variant D, *Oliver 10676*; B_2, variant E, *Kirsten 811*, De Tronk; B_3, variant A, *Oliver 8013*, Caledon Swartberg; B_4, variant B, *Oliver 11287*, Klein River Mtns. B_5, *E. melastoma* subsp. *minor*, *Baker 1250*, Baardskeerdersbos. C, *E. monadelphia*, *De Vos 648*, Kleinmond. D_1, D_2, *E. intermedia*: D_1, subsp. *intermedia*, from type, *Niven 127*; D_2, subsp. *albiflora*, *Oliver 9105*, Ruitersberg. E, c/s leaf. Scale bars: flowers, 4 mm; anthers, 2 mm; E, 250 µm.

(BM!, NBG!, PRE); *MacOwan sub Herb. Norm. 5* (BM!, K!, SAM!); *Middlemost 1556* (NBG!, NY!); *Oliver STE30141* (BM!, BOL!, NBG!, PRE), *STE30142* (NBG!, P!, PRE); *Zeyher 3185* (BOL!, K!, P!, PRE, SAM!, W).

1b. subsp. **uniflora** *E.G.H.Oliv. & I.M.Oliv.*, subsp. nov., flore uno foliis suberectis ad recurvatis distinguitur.

TYPE.—Western Cape, 3419 (Caledon): Springfield, (–DB), 12 January 1958, *Rycroft 2104* (NBG, holo.; K, PRE).

Diagnostic features: flowers borne singly at ends of short, leafy lateral branches, usually yellow, sometimes orange-red; leaves semi-erect to reflexed.

This is a lowland taxon occurring on hills and flats not far from the coast from the Cape Peninsula eastwards to near Mossel Bay.

Paratype material (selection from numerous collections): WESTERN CAPE.—3418 (Simonstown): Karbonkelberg, 1500 ft [450 m], (–AB), 21-07-1974, *Esterhuysen 33586* (BOL!, NBG!); Sir Lowry's Pass, 1000 ft [300 m], (–BB), 11-07-1890, *Guthrie 2001* (NBG!). 3419

(Caledon): Baviaansfontein, Gansbaai, 800 ft [250 m], (–CB), 14-03-1977, *Hugo 806* (NBG!, PRE); Kleinbos, Die Kelders, 50 ft [15 m], (–DA), 4-11-1969, *Taylor HC 7420* (NBG!, PRE); Bredasdorp Forest Reserve, 60 ft [18 m], (–DC), 12-03-1979, *Thompson MF 3974* (NBG!, PRE). 3420 (Bredasdorp): Potberg, 500–600 ft [150–180 m], (–BC), 19-06-1984, *Oliver 8512* (NBG!). 3421 (Riversdale): Canca, (–BC), 20-03-1975, *Oliver 5739* (NBG!); Ystervarkpunt, 80 m, (–BD), 15-05-1987, *Willemse 185* (NBG!). 3422 (Mossel Bay): Mossel Bay, dunes, (–AA), 08-1962, *Liebenberg 6376* (BM!, NBG!, PRE).

1.1. **E. melastoma** *Andrews*, Coloured engravings of heaths: t. 37 (1799). *E. petiveri* var. *melastoma* (Andrews) Benth.: 622 (1839); Guthrie & Bolus: 47 (1905). *E. follicularis* Salisb. var. *melastoma* (Andrews) Dulfer: 29 (1965). Iconotype: Andrews: t. 37 (1799).

Note: Dulfer overlooked the problem of the dates of publication of Andrews' plates and selected Salisbury's name of 1802 for the species, thereby relegating Andrews' *E. melastoma* to varietal status. Dulfer (1965) cited 1802 as the date of publication for *E. melastoma* which is the date of the bound volume and not the date which is printed on the plate. A paper detailing the publication dates of all Andrews' species is in preparation (Cleevely & Oliver 2002).

Diagnostic features: leaves erect to semi-erect, straight; flowers single on short, leafy side branches; sulcus on sepals, bract and bracteoles very short, apical, broadly open, V-shaped (not narrow, slit-like and forming a keel) or absent.

This is a very variable species in the size of the flowers, size and shape of the sepals, shape and stickiness of the corolla and colour of the corolla apex. Within all this variation there is only one distinct discontinuity, namely in the size of the corolla, and we propose to recognize this at subspecific level.

1.1a. subsp. **melastoma**

E. vestiflua Salisb.: 346 (1802); Guthrie & Bolus: 48 (1905); Dulfer: 30 (1965). Type: sine loc., *Roxburgh s.n.* [*Roxburgh 71* det. Salisbury] (K!).

E. follicularis Salisb.: 348 (1802); Dulfer: 29 (1965). Iconotype: Andrews, Coloured engravings of heaths: t. 44 (1797).

E. petiveri var. *willdenovii* Bolus: 48 (1905). *E. coccinea* var. *willdenovii* (Bolus) H.A.Baker: 184 (1967). Type: *Thunberg s.n.* (UPS).

E. coccinea var. *inflata* H.A.Baker 75 (1958). *E. follicularis* var. *inflata* (H.A.Baker) Dulfer: 30 (1965). Type: Caledon Div., Koude Mountains, between Gaansbaai and Elim, *Baker 1154* (BOL, holo.; NBG!).

Illustration: Baker & Oliver: t. 1, 8 (1967).

Diagnostic features: corolla ± 18 mm long (Figure $1B_4$).

Within the subspecies there is a considerable amount of variation in several characters, mainly the corolla shape, colour and stickiness. Despite there being some collections which appear to be very distinct, we are unable to recognize any formal categories and thus list them here as unnamed variants to show possible groups that need to be worked on in detail in the field and through DNA analyses.

VARIANT A: the corolla is yellow with a dark, almost black, distal end. It may, however, be greenish yellow with the distal end fading to brown soon after anthesis. The typical variant, shown in Andrews' painting, has large sepals, i.e. broad and more than half the length of the corolla tube, the corolla slightly to much inflated towards the base and mostly not sticky although small sessile glands may occur on the margins of the sepals (Figure $1B_3$). The leaves can be short to very long. The distribution is from Stellenbosch to Bredasdorp.

VARIANT B: this variant has flowers similar to Variant A, but they are very sticky and yellowish with a black mouth (Figure $1B_4$). It includes the var. *inflata* and occurs in the Bredasdorp District.

VARIANT C: with similar flowers to A, but not sticky, usually light orange-yellow, mostly with no tufted small side branches typical of the other variants. It occurs on limestone flats of the Bredasdorp District.

VARIANT D: flowers yellow-orange with no black mouth, with long narrow tube and a short calyx less than half the length of the corolla tube, which is not sticky (Figure $1B_1$). This occurs in the region from Tulbagh to the Cederberg.

VARIANT E: flowers the same as those in D above, but very sticky. The stickiness is produced by a remarkable array of sessile glands in several zones around the margins of the sepals (Figure $1B_2$). This variant is found in the Porterville Mountains, but a few collections near Wemmershoek and Baviaansberg, Ceres, have a reduced amount of glands.

Vouchers: *Andreae 686* (NBG!); *Guthrie 2005, 2498* (NBG!); *Hanekom 2941* (NBG!); *Oliver 10676* (NBG!), *STE30143* (BOL!, NBG!, PRE).

1.1b. subsp. **minor** *E.G.H.Oliv. & I.M.Oliv.* subsp. nov., floribus minoribus, 6 ad 7 mm longis, distinguitur. Figura $1B_5$.

TYPE.—Western Cape, 3419 (Caledon): Koueberge, SE-facing slope above Remhoogte, ± 250 m, (–DA), 27 October 2001, *R.C. Turner 401* (NBG, holo.; BM, BOL, K, NY, PRE).

Diagnostic features: corolla 6–7 mm long, yellow with dark mouth (Figure $1B_5$).

The subspecies occurs in the Hermanus and Bredasdorp Districts.

Paratype material: WESTERN CAPE.—3419 (Caledon): Hermanus Mtns, (–AD), 10-1924, *Marloth 6225* (NBG!, PRE); Baardskeerdersbos, (–DA), 8-9-1957, *Baker 1250* (NBG!); Remhoogte, (–DA), 25 October 1967, *Thomas in NBG86471* (NBG). 3420 (Swellendam): Bredasdorp Mtn, (–CA), 15-10-1951, *Esterhuysen 19169* (BOL!, NBG!, PRE). Without locality: Caledon Wildflower Show, 09-1965, *Oliver STE32109* (NBG!).

1.2. **E. intermedia** *Klotzsch ex Benth.* in DC. Prodromus 7: 621 (1839). *E. petiveri* var. *intermedia* (Klotzsch ex Benth.) Bolus: 47 (1905). *E. coccinea* var. *intermedia* (Klotzsch ex Benth.) Dulfer: 29 (1965). Syntypes: Swellendam, *Masson s.n.* (K), *Niven s.n.* (BOL!, K), *Ecklon s.n.* (B†). Lectotype to be selected from the material used by Bentham in K.

Diagnostic features: anther apices acuminate; corolla distinctly longer than calyx, ± 6–11 mm long.

1.2a. subsp. **intermedia**

Diagnostic features: flowers green to yellow-green, 8–11 mm long; corolla tubular-ovoid; bract, bracteoles and sepals with small sessile glands and short hairs on margins (Figure $1D_1$).

This occurs along the Langeberg and Outeniqua Ranges from Swellendam to George.

Vouchers: *Fourcade 5693* (NBG!, PRE), *4706* (BOL!, PRE); *McDonald 1274* (NBG!); *Rourke 294* (NBG!); *Taylor LE 3014* (NBG!).

1.2b. subsp. **albiflora** *E.G.H.Oliv. & I.M.Oliv.*, subsp. nov., floribus albis minoribus corolla 5.5–6.0 mm longa late ovoidea, glandibus in marginibus bracteae, bracteoleae sepalorumque distinguitur. Figura 1D$_2$.

TYPE.—Western Cape. 3322 (Oudtshoorn): Ruitersberg, N slopes at W end, 3000 ft [910 m], (–CC), 11 March 1988, *Oliver 9105* (NBG).

Illustration: Schumann & Kirsten: 35, t. 1 (1992).

Diagnostic features: flowers white; corolla broadly ovoid, 5.5–6.0 mm long; bract, bracteoles and sepals with only small sessile glands on margins and no hairs admixed (Figure 1D$_2$).

The subspecies occurs in the Robinson Pass/Ruitersberg to Jonkersberg area of the Outeniqua Mountains.

Paratype material: WESTERN CAPE.—3322 (Oudtshoorn): Outeniqua Mtns, Ruytersbosch, (–CC), 19-09-1951, *G. van Niekerk 79* (BOL!, NBG!); Robinson Pass, 1850 ft [560 m], (–CC), 2-04-1979, *Campbell 13342* (NBG!); ibid., 30-06-1947, *Compton 19595* (NBG!); ibid., 2-05-1974, *Goldblatt 1781* (MO, NBG!); Ruitersberg, 3000 ft [914 m], (–CC), 11-03-1988, *Oliver 9105* (NBG!); ibid., 765 m, 5-04-1994, *Oliver 10429* (NBG!); Jonkersberg, (–CC), 29-08-1978, *W. Bond 1462* (NBG!); ibid., 790 m, 4-02-1986, *Brusse 4794* (NBG!, PRE); ibid., 09-1912, *Rogers 4273* (NBG); ibid., 2-06-1951, *L.E. Taylor 3006* (NBG!, PRE); ibid., *Van Breda & Admiraal 2105* (NBG!, PRE); ibid., 2600 ft [790 m], 6-02-1978, *Williams 2433* (NBG!); Engelsberg, 1800 ft [549 m], (–CC), 23-10-1984, *Vlok 858* (NBG!, PRE).

2. ***E. vestiflua*** Salisb.—see *E. melastoma* subsp. *melastoma* (1.1a).

6. **E. monadelphia** *Andrews*, Coloured engravings of heaths: t. 38 (1797); Benth.: 622 (1839); Guthrie & Bolus: 50 (1905); Dulfer: 32 (1965) cum auct. Willd. Iconotype: Andrews: t. 38 (1797).

Note: Andrews published the name as 'monodelphia' in the protologue (text and plate), but later changed it to 'monadelphia' in the index which was published some five years later in 1802 when the completed volume was bound. He also used the spelling 'Monadelphia'. This latter spelling was taken up by all subsequent authors who did not query the '-ia' ending. There is no indication why Andrews used this substantival epithet in apposition. This could be assumed to be Linnaeus' major Class name, Monadelphia (stamens united by their filaments into one body) (Stearn 1957: 31). The grammatically correct adjectival epithet would be 'monodelpha'.

Illustrations: Baker & Oliver: t. 6 (1967); Schumann & Kirsten: 37, t. 1 (1992); Oliver & Oliver: t. 3 (2000).

Diagnostic features: anthers with a distinct boundary between thecae and filament, and a slight basal adaxial 'nose'; corolla tube straight, ± 11 mm long, bright red (Figure 1C).

This is a distinct species within the '*coccinea*' complex and not with *E. banksii* as its number would suggest. There are two branching forms within the species—one with numerous very short side branches as in *E. coccinea*, the other without these. The species is a resprouter after fires.

Vouchers: *Baker 1886* (NBG!); *Oliver 3360* (NBG!, PRE); *Oliver & Palser 78* (K!, NBG!, PRE); *Salter 4278* (BM!, BOL!, K!, PRE); *Schlechter 9750* (BM!, BOL!, K!, PRE).

ERICA PLUKENETII COMPLEX

Three separate species used to be recognized in this complex—*E. plukenetii*, *E. lineata* and *E. breviflora*.

3. ***E. lineata*** Benth.—see *E. plukenetii* subsp. *lineata* (5d).

4. ***E. breviflora*** Dulfer—see *E. plukenetii* subsp. *breviflora* (5e).

5. **E. plukenetii** *L.*, Species plantarum, edn 1, 1: 356 (1753); Benth.: 622 (1839); Guthrie & Bolus: 50 (1905); Dulfer: 31 (1965). Lectotype: Plukenet, Almagesti Mantissa botanici 45: t. 344, fig. 3 (1700) selected here by Oliver, Jarvis & Cafferty, in prep.

Note: the iconotype accurately reflects Plukenet's specimen, Herb. Sloane 89: 11 (BM! photo.–NBG).

Diagnostic features: bract and bracteoles very reduced, remote from calyx; anthers exserted, long attenuated with rounded apices; placenta covered entirely by ovules abaxially; seeds reticulate.

The main variation in this species is in the length and shape of the corolla and sepals, size and texture of the leaves, and in its habit. The flowers are 7–16(–28) mm long with a tubular or inflated tubular corolla with far-exserted stamens (Figure 2). Flowers change shape as they mature, often being rather slender in bud and quite inflated at maturity. The sepals range from 2–12 mm long, lanceolate to ovate in shape with the sulcus as long as the sepal. The plants are mostly reseeders, but can be resprouters in some areas, and can vary from woody, rounded shrubs 0.75 m tall near the coast, to tall delicate erect shrubs in the Bredasdorp District. In the Kamiesberg the multi-stemmed resprouters can be up to 3 m tall.

This species is often confused with species in the *E. coccinea* complex. The position and size of the bract and bracteoles is the most visible character to distinguish it from that group.

5a. subsp. **plukenetii**

E. plukenetii var. *densa* Bartl.: 630 (1832); Dulfer: 31 (1965). Type: Caledon und Hottentotsholland, *Ecklon s.n.* (?).

E. plukenetii var. *brachysepala* Bartl.: 631 (1832); Dulfer: 31 (1965). Type: Zwischen Sträuchen am Fusse des Teufelsbergs [Table Mtn] in zweiter Höhe, *Ecklon s.n.* (P!).

E. plukenetii var. *brevifolia* Bolus: 50 (1905); Dulfer: 31 (1965). Type: Piquetberg Div.; Piquetberg Range, *Schlechter 5208* (BOL!).

Illustrations: Baker & Oliver: t. 2 (1967); Schumann & Kirsten: 36, t. 7, 8, 9 (1992); Oliver & Oliver: t. 1 (2000).

Diagnostic features: sepals 2–8 mm long, short and ovate to longer and lanceolate (Figure 2A, B).

There is considerable overlapping variation in the length of the leaves and in the width and length of the sepals. This subspecies also exhibits considerable range in the size of its flowers.

Vouchers: *Barker 10423* (MO!, NBG!); *Maguire 1129* (NBG!, NY!); *Oliver 3764* (K!, NBG!, PRE), *4918* (NBG!, PRE); *Oliver & Palser 22* (K!, NBG!, PRE); *Phillips 7587* (K!, NBG!, NY!, PRE); *Rycroft 1949* (NBG!, P!); *Schlechter 5208* (BM!, BOL!, K!, NBG!).

5b. subsp. **bredensis** *E.G.H.Oliv. & I.M.Oliv.*, subsp. nov., sepalis latibus ± 5–6 × 3 mm foliis 7–10(–12) mm longis dignoscenda. Figura 2E.

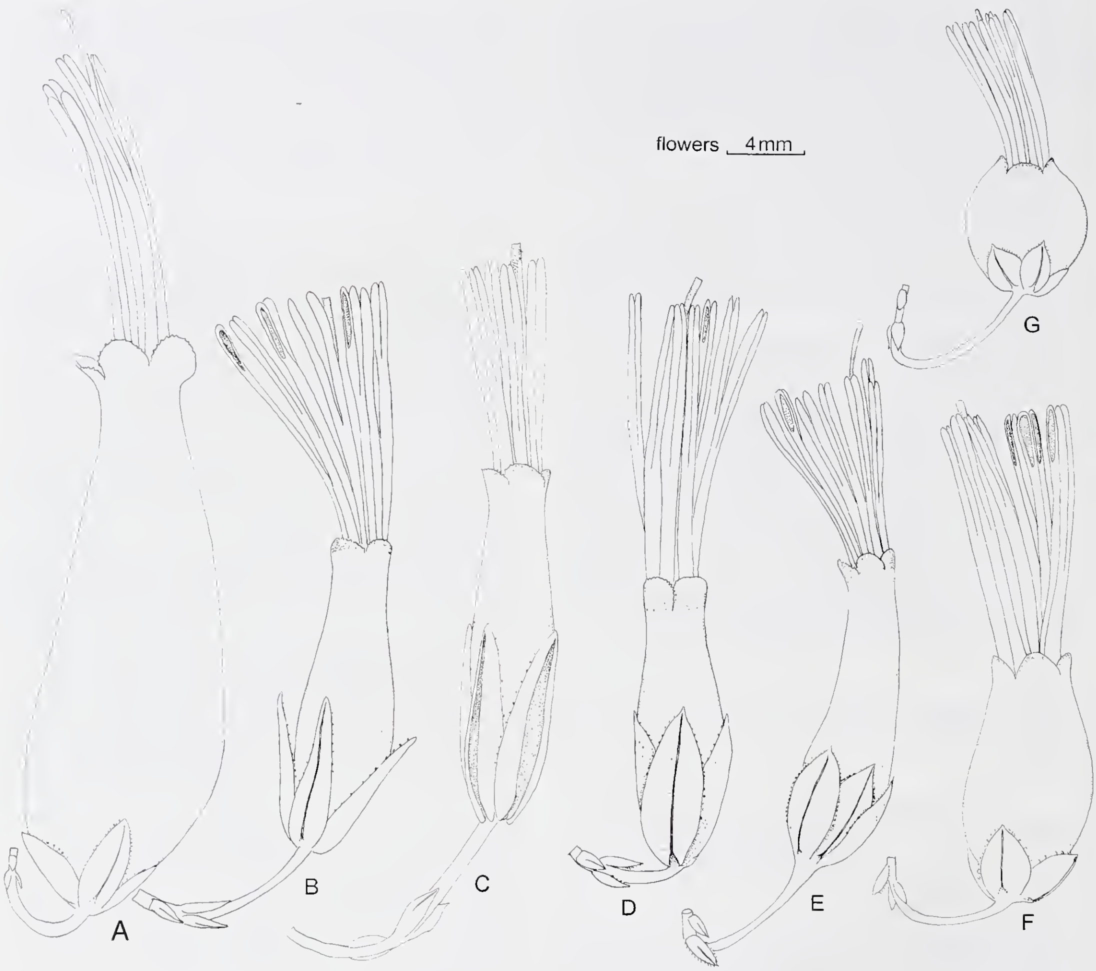

FIGURE 2.—*Erica plukenetii* complex. A, B, subsp. *plukenetii*: A, *Oliver 5953*, Kamiesberg; B, *Rycroft 1949*, Bainskloof. C, subsp. *penicellata*, *Oliver 4226*, Stanford; D, subsp. *lineata*, *Oliver 8749*, Pearly Beach, Carruther's Hill; E, subsp. *bredensis*, *Marsh 1468*, Cape Infanta. F, G, subsp. *breviflora*: F, *Taylor 11670*, Cederberg; G, *Rourke 653*, Boboskloof. Scale bar: A–G, 4 mm.

TYPE.—Western Cape, 3420 (Bredasdorp): De Hoop Nature Reserve, 100 ft [30 m], (–AD), 28 July 1970, *Marsh 1468* (NBG).

Diagnostic features: sepals broad (elliptic to ovate), ± 5–6 × 3 mm, leathery; leaves 7–10(–12) mm long; corolla ± 15 mm long, white with a pink mouth, red or occasionally yellowish (Figure 2E). Flowers look very much like those of subsp. *lineata*, but leaves are broader and shorter.

The taxon occurs on limestone hills and lateritic flats from Heuningrug south of Bredasdorp, eastwards as far as Cape Infanta and also on the sandstone of Potberg. There are numerous collections from this area.

Paratype material (selection from many specimens): WESTERN CAPE.—3419 (Caledon): Bredasdorp Dist., Heuningrug, 70 m, (–DB), 1-04-1995, *Paterson-Jones 218* (NBG!); De Hoop area, (–AD), 8-04-1957, *Barker 8681* (NBG!); ibid., 200 m, 14-06-1979, *Burgers 1865* (NBG!); ibid., Hardevlakte, 10-03-1985, *Fellingham 947* (NBG!); Albertsdal, (–BC), 31-05-47, *Barker 4553* (NBG!); Potberg, Elandspad, 600 ft [182 m], (–BC), 1-05-1985, *Leith 51* (NBG!, PRE); Cape Infanta, 150 ft [45 m], (–BD), 7-04-1984, *Oliver 8428* (NBG!); Die Poort, (–CA), 10-08-1949, *Steyn 341* (NBG!); Moerasfontein, 50 ft [15 m], (–CB), 15-03-1977, *Thompson 3430* (NBG!, PRE).

5c. subsp. **penicellata** *(Andrews) E.G.H.Oliv. & I.M.Oliv.* stat. et comb. nov.

E. penicillata Andrews, Coloured engravings of heaths 2: t. 116 (1802). Iconotype: Andrews: t. 116 (1802).

E. revolvens Bartl.: 631 (1832). *E. plukenetii* var. *bicarinata* Bolus: 51 (1905); Dulfer: 31 (1965). Type: berge bei Gnadenthal, *Ecklon s.n.* (?holo.; ?P). Note: the collection in P is this species, but not yet verified as this subspecies.

Diagnostic features: sepals up to 12 mm long, thick and fleshy, with distinctive non-revolute thick margins forming two longitudinal keels like a catamaran (Figure 2C), bases of these keels produced into small lobes beyond point of attachment to pedicel. These features are well displayed in Andrews' drawing. Bartling's description fits this taxon—'sepalis base productis solutis, margine revolutis'.

Vouchers: *Oliver 4226* (NBG!); *Schlechter 7743* (BM!, BOL!, K!, PRE).

5d. subsp. **lineata** *(Benth.) E.G.H.Oliv. & I.M.Oliv.*, stat. et comb. nov.

E. lineata Benth. in DC., Prodromus 7: 622 (1839); Guthrie & Bolus: 48 (1905); Dulfer: 30 (1965). Type: in colonia Capensi [Cape Colony], *Mund s.n.* (K!).

Illustrations: Baker & Oliver: t. 3 (1967); Schumann & Kirsten: 35, t. 3, 4 (1992).

Diagnostic features: leaves very long, narrow; sepals (Figure 2D) broad and flat sepals like those in subsp. *bredensis*.

The subspecies occurs on sandy soils associated with coastal limestone deposits from Gansbaai to Zoetanysberg.

Vouchers: *Kerr STE30029* (BM!, K!, NBG!, PRE); *Oliver 3365* (NBG!, PRE); *Schlechter 9711* (BM!, BOL!, K!, P!, PRE, SAM!, W).

5e. subsp. **breviflora** *(Dulfer) E.G.H.Oliv. & I.M.Oliv.*, stat. et comb. nov.

E. breviflora Dulfer in Annalen des Natürhistorischen Museums, Wien 68: 30 (1965). Type: *Thunberg s.n.* (UPS).

E. scariosa Thunb.: 350 (1823); Guthrie & Bolus: 49 (1905); non P.J.Bergius (1767). Type: as for *E. breviflora* above.

E. penicillata Benth.: 622 (1839), non Andrews, Coloured engravings of heaths 2: t. 116 (1802) (see subsp. 5c).

Illustrations: Schumann & Kirsten: 36, t. 5, 6 (1992).

Diagnostic features: corolla short, ovoid to almost globose, mostly ± 7 mm but less than 12 mm, white, occasionally pink; synflorescence typically very long spike-like up to 250 mm long (Figure 2F, G).

There is an increase in flower size in some collections from the Cederberg together with a reduction in the length of the synflorescences. These can merge with some short variants of subsp. *plukenetii* in the Franschhoek Mountains. We have noted that populations in the Porterville Mountains have flowers that are sweetly scented. This coupled with the smaller flowers would indicate that the subspecies is pollinated by insects as opposed to the postulated bird-pollinated, longer flowers of all the other subspecies. The plants are single-stemmed reseeders.

Guthrie & Bolus (1905) noted under *E. scariosa* 'we admit this species with doubt' and kept it as distinct 'with some reluctance'.

The subspecies occurs in the Cederberg to Porterville and the southern Cold Bokkeveld area.

Vouchers: *Bolus 5114* (BM!, BOL!, K!, PRE, SAM!); *Drege 7694* (BM!, K!, NBG!, PRE, W); *Oliver 4075* (NBG!, PRE); *Rourke 653* (K!, NBG!); *Schlechter 9084* (BM!, K!, NBG!, PRE).

6. ***E. monadelphia*** Andrews—this has been placed in the *E. coccinea* group after *E. intermedia* (1.2).

7. **E. banksii** *Andrews*, Coloured engravings of heaths 1: t. 5 (1797) as *E. banksia*; Willd.: 395 (1799); Bauer: t. 29 (1803); Benth.: 624 (1839); Dulfer: 32 (1965); as *banksia* Guthrie & Bolus: 51 (1905). Iconotype: Andrews: t. 5 (1797).

Note: as with several other epithets coined by Andrews, the '-ia' ending was thought to reflect the use of a generic name used in apposition, in this case *Banksia* (Australian Proteaceae), and should not be corrected. However, there are some cases where a generic name did not exist or was coined later than the publication of the species name. These -ia endings are being replaced by the relevant genitive ending (-i, -ii, -ae or -iae) for all Andrews' names commemorating persons. The date of the Bauer plate is actually 1 Jan. 1801 and not the date of the first published fascicle in the bound publication, i.e. 1796, as used by Dulfer to antedate Bauer's name over that of Andrews. However, fascicle 3 containing this plate only appeared in 1803 (Britten 1899).

Diagnostic features: anthers well exserted with filaments held in a tight bundle, bilobed with basal attachment and distinct basal 'chin'; corolla lobes spreading to reflexed; tube straight, white or greenish with lobes green or purple; leaves slightly serrated with sharp, short to long mucro and longish petiole; bract and bracteoles large and approximate to calyx; sepals with terminal sharp mucro. Inflorescences numerous, pendulous, consisting of 3-nate flowers at ends of main branches.

7a. subsp. **banksii**

Diagnostic features: leaves short, ± 5–6 mm long; corolla yellowish green; ovary hairy (Figure 3A).

The typical subspecies forms a small, compact, woody shrublet growing on rock ledges and occurs in the mountains around the Elgin Basin.

Vouchers: *Esterhuysen 2695* (BOL!, NBG!, PRE): *Schlechter 7572* (BOL!, K!, PRE).

7b. subsp. **purpurea** *(Andrews) E.G.H.Oliv. & I.M.Oliv.*, stat. et comb. nov.

E. banksia var. *purpurea* Andrews, The Heathery 3: t. 106 (1806); Guthrie & Bolus: 51 (1905). *E. banksia* var. *purpurea* (Andrews) Dulfer: 32 (1905). Iconotype: Andrews: t. 106 (1806). Note: Andrews' painting in Coloured engravings of heaths: t. 151 is not dated, so the volume date has to be used in this case, namely 1809.

Illustrations: Baker & Oliver: t. 5 (1967); Schumann & Kirsten: 38, t. 3, 4 (1992).

Diagnostic features: corolla white with purple lobes; leaves short, ± 5–9 mm long; ovary glabrous.

This subspecies grows on the mountains from Babylon's Tower southeast to Quoin Point.

Vouchers: *Oliver STE30033* (BOL!, K!, NBG!, PRE); *Zeyher 3189* (BOL!, P!, W).

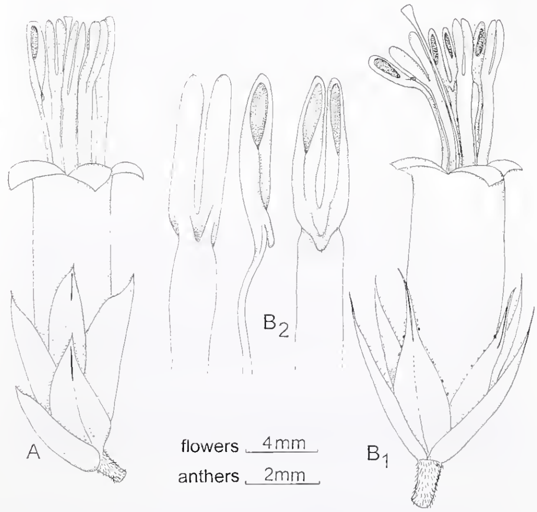

FIGURE 3.—*Erica banksii*. A, subsp. *banksii*, *Esterhuysen 2695*, Rooskraalberg; B_1, B_2, subsp. *comptonii*, holotype, *Compton 6066*, Hangklip. Scale bars: A, B_1, 4 mm; B_2, 2 mm.

7c. subsp. **comptonii** *(Salter) E.G.H.Oliv. & I.M.Oliv.*, stat. et comb. nov.

E. comptonii Salter in Journal of South African Botany 2: 60 (1936); Dulfer: 32 (1965). Type: Caledon Div., among rocks, northeast slope of Hangklip, 1400 ft [426 m], Jan, *Compton 6066* (BOL!, K!, NBG!).

Illustrations: Baker & Oliver: t. 4 (1967); Schumann & Kirsten: 38, t. 5, 6 (1992).

Diagnostic features: corolla greenish white; leaves long, 12–20(–26) mm long; ovary glabrous (Figure 3B).

This subspecies is confined to the higher mountain peaks from Kogelberg to Hangklip. In the Kogelberg complex the subsp. *banksii* occurs at lower altitudes at the northeastern end.

Subsp. *comptonii* differs from the other two subspecies in the larger, more open habit (up to 500 mm tall) in open ground between rocks and in the longer leaves (up to 26 mm) with longer mucros on the leaves and sepals (Figure $3B_1$). The sepals can vary from about half to the full length of the corolla tube.

The variation in this species occurs in the flower colours, the habit, habitat, length of leaves and length of the mucro on the leaves and sepals. Disjunctions occur regionally, but warrant recognition only at subspecific level.

Vouchers: *Boucher 1332* (NBG!, PRE); *Compton 6066* (BOL!, K!, NBG!); *Pillans 8183* (BOL!, K!).

8. ***E. primulina*** Bolus—see *E. viridiflora* subsp. *primulina* (9b).

8.1. **E. leucosiphon** *L.Bolus* in Kew Bulletin 1933: 186 (1934); Dulfer: 32 (1965). Type: Cape Town Wild Flower Show, *BOL19253* (BOL!).

Illustrations: Schumann & Kirsten: 39, t. 9, 10 (1992).

Diagnostic features: pedicel long, with dense plumose hairs; calyx white; anther appendages broad; corolla white.

This distinct species has no alliances with any other long-tubed species, but has, rather, an alliance with several species with much shorter flowers, such as *E. monsoniana* L.f. (no. 402) and *E. goatcheriana* L.Bolus (no. 405.1). The possession of plumose hairs on the pedicel are shared by all of them.

Vouchers: *Kellerman 157* (PRE); *Kirsten 434* (NBG!); *Oliver 4101* (NBG!).

9. **E. viridiflora** *Andrews*, The Heathery: t. 299 (1812); Guthrie & Bolus: 52 (1905); Dulfer 32 (1965). Iconotype: Andrews: t. 299 (1812).

Note: Andrews' much fuller painting in Coloured engravings of heaths: t. 287, must have appeared after 1820, which date Andrews mentioned in the text accompanying the plate, even though the volume is dated '1809'.

Diagnostic features: corolla lobes large and erect; anther appendages decurrent along filament, pendulous to very reduced and ear-like.

9a. subsp. **viridiflora**

Illustrations: Baker & Oliver: t. 7 (1967); Schumann & Kirsten: 39, t. 11, 12 (1992).

Diagnostic features: corolla lime-green, sticky, with a patch of sessile, sticky glands in centre of upper half of adaxial surface of sepals. Inflorescence consists of three flowers; it is terminal on main and occasionally secondary branches; bract and bracteoles approximate to calyx; anthers bilobed with thecae often divergent; ovary ovoid and glabrous (Figure 4A).

The typical subspecies forms an erect shrub, 0.5–1.0 m tall, growing in open ground or between rocks. It occurs on the coastal mountains from George through to Humansdorp.

Erica clavata Andrews (Coloured engravings of heaths: t. 159, 1809) was included by Guthrie & Bolus (1905) and Dulfer (1965) in synonymy. Careful examination of his painting leads to the conclusion that *E. clavata* could be a hybrid with *E. viridiflora* as a possible parent. Characters which do not fit the current taxon are the erect imbricate leaves, the broadly ovate sepals with long attenuate apices, and the muticous anthers.

Vouchers: *Oliver STE30030* (BM!, BOL!, K!, NBG!, PRE!); *Schlechter 5801* (BM!, BOL!, K, PRE, W).

9b. subsp. **primulina** *(Bolus) E.G.H.Oliv. & I.M. Oliv.*, stat. et comb. nov.

E. primulina Bolus in Flora capensis 4: 51 (1905); Dulfer: 32 (1965). Type: Ladismith Div., on rocky mountain slopes of the Klein Zwartbergen, near Seven Weeks Poort, 3250 ft [990 m], *Marloth 2937* (BOL!).

Illustrations: Schumann & Kirsten: 39, t. 7, 8 (1992).

Diagnostic features: corolla cream to greenish, nonsticky; shrubs small, woody shrublets, erect to 300 mm

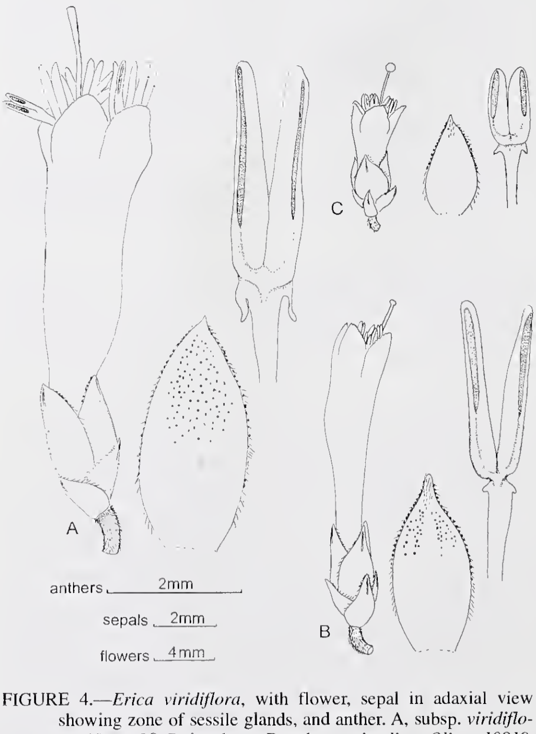

FIGURE 4.—*Erica viridiflora*, with flower, sepal in adaxial view showing zone of sessile glands, and anther. A, subsp. *viridiflora*, *Visser 29*, Ruitersberg; B, subsp. *primulina*, *Oliver 10819*, Meiringspoort; C, subsp. *redacta*, *Vlok s.n.*, Meiringspoort. Scale bars: anthers, sepals, 2 mm; flowers, 4 mm.

high but sometimes prostrate (Figure 4B).

Subsp. *primulina* occurs only in the Swartberg Range from the Klein Swartberg to near Willowmore. A collection from Gamkaberg, which is further to the south and west than the rest of the collections, is an intermediate variant having the flowers of this subspecies, but the growth of subsp. *viridiflora*—it is recorded as a woody erect shrub 500 mm tall.

In the protologue, Bolus mentioned the affinity with *E. viridiflora*, but surprisingly stressed a closer likeness to *E. banksii* and gave the differences from that species.

Vouchers: *Esterhuysen 6286* (BOL!, K!, NBG!, PRE); *Oliver 3436* (NBG!).

9c. subsp. **redacta** *E.G.H.Oliv. & I.M.Oliv.*, subsp. nov., a subspecie typica floribus multo minoribus differt. Figura 4C.

TYPE.—Western Cape, 3322 (Oudtshoorn): Meiring's Poort, (–BC), 14-10-2001, *Vlok & Schutte 458* (NBG, holo.; BM, K, NY, MO, PRE).

Diagnostic features: differs from subsp. *primulina* only in size of flowers and their parts, corolla 4.5–5.0 mm long (Figure 4C).

This small-flowered form is restricted to a single population of some 100 plants occurring in crevices on a large steep slab of quartzite rock. The plants were about 200 mm tall and bore creamy white to sometimes green-tinged flowers. Subsp. *primulina* grows in similar habitats in the vicinity.

This is clearly a case of a short-tubed variant adapted to a different pollination syndrome (insect versus bird).

Paratype material: WESTERN CAPE.—3322 (Oudtshoorn): Meiring's Poort, (–BC), 01-2001, fruiting, *Vlok s.n.* (NBG).

10. ***E. sphenanthera*** Tausch, Flora: 17: 626 (1834); Guthrie & Bolus: 52 (1905); Dulfer: 33 (1965). Type: without locality or collector (PRG!, holo.; photo. –NBG!).

This taxon is regarded as a hybrid of garden origin in Europe. No material matching the description and the type has been found in the Cape. Parentage could include *E. abietina* because of the similar bracteoles, anthers and ovary.

11. ***E. cerviciflora*** Salisb. in Transactions of the Linnean Society 6: 362 (1802); Guthrie & Bolus: 53 (1905); Dulfer: 33 (1965). Type: Hottentots Holland, *I. Mulder s.n.* (K!).

No material matching the description and type has been found in the Cape. We postulate that this collection is of hybrid origin in the wild. Parentage could include *E. abietina* because of the similar anthers and ovary. Jacob Mulder is known only through the citation by Salisbury of 37 species of *Erica* from the Cape (Gunn & Codd 1981). Only one specimen is labelled as a Mulder collection by Salisbury.

11.1. **E. beatricis** *Compton* in Journal of South African Botany 9: 128 (1943); Dulfer: 33 (1965). Type: Uniondale Dist., Helpmekaar (or Thumb) Peak, *Bond 892* (NBG!).

Illustration: Compton, l.c., t. 8 (1943).

Diagnostic features: anthers exserted, with short stubby appendages below thecae; ovary puberulous; corolla glabrous; stems, leaves, pedicel, bract, bracteoles and sepals all puberulous.

This species has been collected only once. There are no indications of its alliances. There is a possibility that it is a naturally occurring hybrid, as found in several other supposedly rare species that have been investigated in the wild, e.g. *E.* × *flavisepala* (Oliver 1977) and *E.* × *vinacea* (Oliver 1986).

Vouchers: *Bond 892* (NBG!); *Esterhuysen 5021* (BOL!).

The remaining 24 species with whole numbers dealt with in this paper were placed by Guthrie & Bolus (1905) in §*Evanthe* which was based on 'Inflorescence mostly axillary, more rarely also terminal on the same plant. Corolla tubular, mostly over 6 lin. [12 mm] long, rarely shorter.' The inflorescence is 1-flowered on a very short lateral branchlet often less than 1 mm long and sometimes bearing very reduced scarious leaflets. These occur in the axils of leaves on the main branch (hence axillary) and are arranged in dense spike-like synflorescences towards the ends of the main branches which continue their vegetative growth. This contrasts with the often 3-nate inflorescences on leafy lateral branchlets found in §*Pleurocallis* which will be dealt with in Part 2.

The inclusion of species in this section, §*Evanthe*, has been rather arbitrary, being based mainly on the size of the corolla. Species with smaller flowers, but with the same inflorescence structure, have been included in §*Hermes*, and one of these is certainly very closely related to some species in this section, e.g. *E. axilliflora* L.Bolus.

12. **E. mammosa** *L.*, Mantissa plantarum altera: 234 (1771); Benth.: 624 (1839); Guthrie & Bolus: 53 (1905); Dulfer: 33 (1965). Lectotype: *Herb. Linn. 498.33* (LINN), selected here by Oliver, Jarvis & Cafferty in prep.

E. gilva J.C.Wendl.: 48 et fig. (1798); Benth.: 624 (1839); Guthrie & Bolus: 54 (1905). Type: *sine. coll. et loc.* (?); iconotype: J.C.Wendl. fig. (1978).

Illustrations: Baker & Oliver: t. 9 (1967); Schumann & Kirsten: 40, t. 1–3; 42, t. 5, 6 (1992); Oliver & Oliver: t. 4 (2000).

Diagnostic features: corolla narrowed at base with 4 indentations or folds, glabrous; bract and bracteoles small and remote from calyx; anthers with long thin appendages and a basal, projecting 'nose'; leaves erect and green; ovary short, rounded and glabrous.

We agree with Salter's reduction of *E. gilva* to synonymy under *E. mammosa*, both having four broad to narrow indentations at the base of the corolla. The former occurs only on Table Mountain on the Cape Peninsula and was separated by Guthrie & Bolus (1905) on the longer bract, bracteoles and sepals—it has white flowers sometimes with a green tip. There is a lot of variation in the colour of the flowers on the Peninsula, particularly in the southern parts and some plants in the Cape of Good Hope Nature Reserve have very long spike-like synflorescences.

Erica mammosa is widespread from the Cape Peninsula to the Cold Bokkeveld and eastwards to Bredasdorp with flowers orange or deep purple-red, greenish yellow to white. Variations occur in the length of the spike-like synflorescence from short and dense to

very long (up to 250 mm) and rather open. The pedicel can be glabrous or hairy and the sepals 3–6 mm long. On the mainland the plants are resprouters, whereas on the Peninsula they may be resprouters or single-stemmed reseeders. The most variation occurs on the mountains above Simonstown.

Vouchers: *Bolus 3354* (BM!, BOL!, K!, P!, PRE, SAM!); *Schlechter 10115* (BM!, K!, P!, PRE, W).

13. ***E. broadleyana*** Andrews, Coloured engravings of heaths: t. 154 (1809). Type: Andrews: t. 154 (1809).

This is regarded as a hybrid of garden origin in England. The plant looks like *E. plukenetii*, but has included anthers. Andrews' drawing shows the upper part of the filaments zig-zagged, which condition would indicate that the anthers could become exserted from the very narrow mouth.

14. **E. baueri** *Andrews*, The Heathery: t. 252 (1812) as *bauera*; Dulfer: 33 (1965). Iconotype: Andrews: t. 252 (1812).

Note: Andrews' epithet is corrected to the genitive case instead of the generic name, *Bauera*, used in apposition (see note under *E. banksii* no. 7).

E. bowieana Lodd.: t. 842 (1824); Benth.: 624 (1839); Guthrie & Bolus: 54 (1905). Iconotype: Lodd.: t. 842.

Illustrations: Baker & Oliver: t. 10 (1967); Schumann & Kirsten: 40, t. 4 (1992).

Diagnostic features: corolla base inflated and rounded with no indentations, white or shell pink; anthers with basal nose and long thin appendages; leaves usually greyish and recurved; long curved pedicel, small bract and bracteoles remote from calyx; ovary short, rounded, glabrous.

14a. subsp. **baueri**

Diagnostic features: leaves short, spreading to recurved; flowers usually 10–20 in few short dense subterminal spike-like synflorescences, white to pale pink.

This commonly cultivated and well-known subspecies is now becoming rare in its habitat due to the spread of agriculture and alien vegetation (mainly *Acacia cyclops*) in the sandy flats which are derived from quartzitic sandstone and lie west of Albertinia.

Vouchers: *Kerr STE30084* (BOL!, K!, NBG!, PRE); *Oliver 174 sub Baker 1589* (BM!, NBG!).

14b. subsp. **gouriquae** *E.G.H.Oliv. & I.M.Oliv.*, subsp. nov., a subspecie typica foliis erectis floribus plus numerosis plus sparsis differt. Figura 5.

TYPE.—Western Cape, 3421 (Riversdale): Albertinia, Rein's Coastal Nature Reserve, main valley just N of Trig. Beacon 64, 150 m, (–BC), *E.G.H. & I.M.Oliver 11933* (NBG, holo.; BM, BOL, E, K, MO, NY, P, PRE, S).

Diagnostic features: leaves erect; flowers 5–10 in loose, spike-like synflorescences, more numerous and scattered over shrub, pale to deep pink (Figure 5).

This subspecies forms a taller, denser shrub up to 2.5 m. It grows very localized in sandy areas associated with limestone between the hills to the south of Albertinia near the coast, an area called Gouriqua.

Paratype material: WESTERN CAPE.—3421 (Riversdale): Buffelshoek, N of Ystervarkpunt, 140 m, (–BC), 13-09-1983, *Burgers 3152* (NBG!); Ystervarkpunt/Gouriqua, 130 m, (–BC), 9-07-1987, *Willemse 624* (NBG!); ibid., 200 m, 27-10-1986, *T.J. van der Merwe 146* (NBG!).

15. ***E. gilva*** J.C.Wendl., see under *E. mammosa* (12).

16. **E. sessiliflora** *L.f.*, Supplementum plantarum: 222 (1782); Benth.: 625 (1839); Guthrie & Bolus: 55 (1905). Type: Cap. bonae spei, *sine coll.* (UPS).

E. clavaeflora Salisb.: 365 (1802). *E. sessiliflora* var. *clavaeflora* (Salisb.) Bolus: 55 (1905); Dulfer: 34 (1965). Type: *comm. Hibbert s.n.* (K!).

E. sceptriformis Salisb.: 365 (1802). *E. sessiliflora* var. *sceptriformis* (Salisb.) Bolus: 55 (1905); Dulfer: 34 (1965). Type: sine loc. *Roxburgh s.n.* (K!).

E. sessiliflora var. *oblanceolata* Bolus: 55 (1905); Dulfer: 34 (1965). Type: sine loc., *Guthrie 3795* (BOL).

Illustrations: Baker & Oliver: t. 8 (1967); Schumann & Kirsten: 42, t. 7–9 (1992); Oliver & Oliver: t. 5 (2000).

Diagnostic features: pedicel very short; bract, bracteoles and sepals equally long and becoming enlarged, fleshy and persistent in fruiting stage; corolla pale green to yellowish green; sepals spathulate with entire to serrated margins; anther appendages narrow; ovary short, rounded and glabrous.

This is a very distinctive species being the only one in the genus exhibiting serotiny—the fruiting synflorescences remain on the plants for several seasons as cone-like structures with the fruits protected by the thickened calyces. The species is very variable in the size of the corolla and in the shape of the sepals from narrowly oblanceolate to very broadly spathulate—characters used to separate several varieties by previous authors. There is, however, no clear-cut disjunction between these shapes that warrant recognition. A very showy variant occurs on the Riviersonderend Mountains with green corolla and bright red sepals compared to the normal green sepals.

Vouchers: *Burchell 5354* (NBG!, NY!, W); *Compton 14230* (NBG); *Oliver 8995, 11236* (NBG); *Parker 3798* (BOL!, NBG!); *Schlechter 7583* (BM!, K!, NBG!, PRE, W).

17. **E. filipendula** *Benth.* in DC., Prodromus 7: 663 (1839); Guthrie & Bolus: 56 (1905); Dulfer: 34 (1965). Type: Cape Colony, *Bowie s.n.* (K!).

Diagnostic features: corolla cyathiform or slightly closed at mouth, 5–10 mm long; sepals narrow lanceolate, about $^1/_3$–$^1/_2$ length of corolla; anther appendages narrow with very few lateral teeth, anther nose long, erect to absent.

17a. subsp. **filipendula**

Illustrations: Baker & Oliver: t. 13 (1967); Schumann & Kirsten: 43, t. 12, 13 (1992).

Diagnostic features: corolla cyathiform, 8–10 mm long, yellow or dark pink; anthers situated in middle of corolla. Figure 6B.

The typical subspecies occurs on sandy hills between Viljoenshof and Pearly Beach in the Bredasdorp District. Both colour forms have been noted growing sympatrically.

Vouchers: *Baker 1775* (BM!, NBG!); *Bolus 8450* (BM!, BOL!, PRE); *Guthrie 3786* (BOL!, NBG!); *Oliver 3414* (NBG!, PRE), *8748* (NBG!).

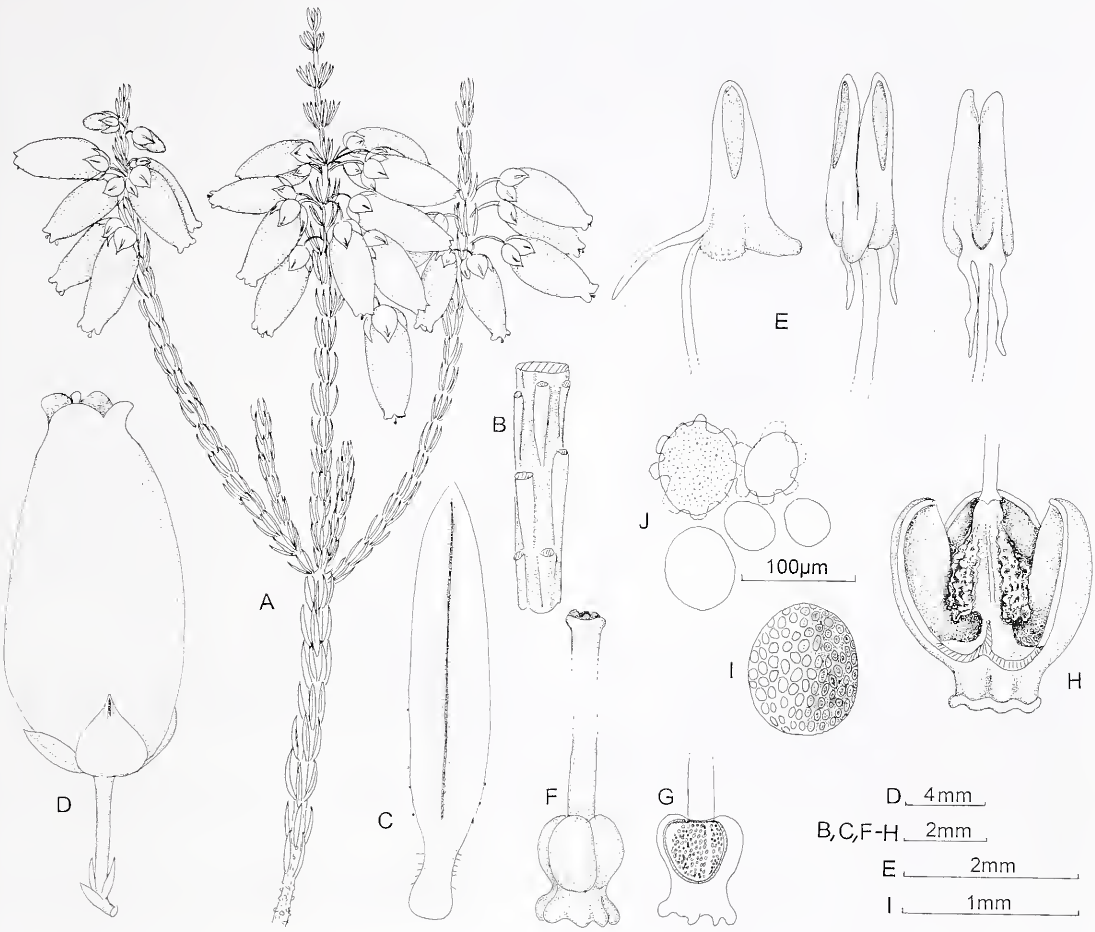

FIGURE 5.—*Erica baueri* subsp. *gouriquae*, *Willemse 624*. A, flowering branch, × 1; B, stem with leaves removed; C, leaf; D, flower; E, anther, side, front and back views; F, gynoecium; G, ovary, opened laterally; H, capsule; I, seed; J, testa cells. Scale bars: B, C, E, F–H, 2 mm; I, 1 mm; D, 4 mm.

17b. subsp. **parva** *E.G.H.Oliv. & I.M.Oliv.*, subsp. nov.. subspeciei typicae similis sed floribus albis ad pallide roseis corolla 5–7 mm longa antheris in corolla altioribus differt. Figurae 6C; 7.

TYPE.—Western Cape. 3419DB (Caledon): Bredasdorp Dist., Soetanysberg area, west end just east of Melkpan, 40 m, 12 May 1999, *E.G.H. & I.M. Oliver 11254* (NBG, holo.; BM, K, MO, NY, PRE).

E. filipendula var. *minor* Bolus: 56 (1905) p.p. Syntypes: Bredasdorp Div., between Elim and Ratel River, 200–300 ft [60–90 m], *Guthrie 3784* (BM!, BOL!, SAM!); ibid., *Bolus 8451* (BM!, BOL!); sine loc., *Zeyher 1090* (K!, BOL! fragm.).

Diagnostic features: corolla white to pale pink, urceolate-cyathiform, 5–7 mm long; anthers positioned higher up in corolla than in typical subspecies. Figures 6C; 7.

The type population had flowers varying from white to pink on the same plant and grew with low plants of the green-flowered form of *E. penduliflora* (17.2). The subspecies occurs on sandy flats and hills between Elim and Zoetanysberg. There are numerous collections from this region.

Paratype material: WESTERN CAPE.—3419 (Bredasdorp): Ratel River, 150 ft [45 m], (–DA), 16-07-1895, *Guthrie 3784* (BM!, BOL! fragm., SAM!); Uintjieskuil, near Ratel River, (–DA), *Van Breda 2149* (NBG!); Soetanysberg, W end above Suur-en-Soet, 350 ft [106 m], (–DB), 29-03-1971, *Oliver 3357* (NBG!, PRE); Rietfontein, near homestead, 45 m, (–DB), *Paterson-Jones 234* (NBG!); Rietfontein, (–DB), 14-05-1993, *Schumann 843* (NBG!); 1 mile [1.6 km] N of Soetanysberg, 300 ft [90 m], (–DB), 2-06-1967, *Williams 1005* (NBG!, PRE). Without precise locality: near Elim and Ratel River, 300 ft [90 m], (–DA), 07-1895, *Bolus 8451* (BM!, BOL!).

This species forms a complex with the next two species, which were all treated as one species by Guthrie & Bolus (1905). It varies in a number of characters—size and colour of flowers, form of anther appendages, anther shape and position in the flower (Figure 5). Bolus' var. *major* was removed as a distinct species, *E. penduliflora* (17.2) and Dulfer (1965) described var. *minor* Bolus as *E. globulifera*. The remaining medium to small-flowered forms constitute this species.

17.1. **E. globulifera** *Dulfer* in Annalen des Natürhistorischen Museums, Wien 68: 35 (1965). *E. filipendula* Benth. var. *minor* Bolus: 56 (1905) p.p. Type: Bredasdorp Div., between Elim and Ratel River, 200–300 ft [90 m], *Schlechter 10472* (BM!, BOL!, P!, PRE, SAM!, W).

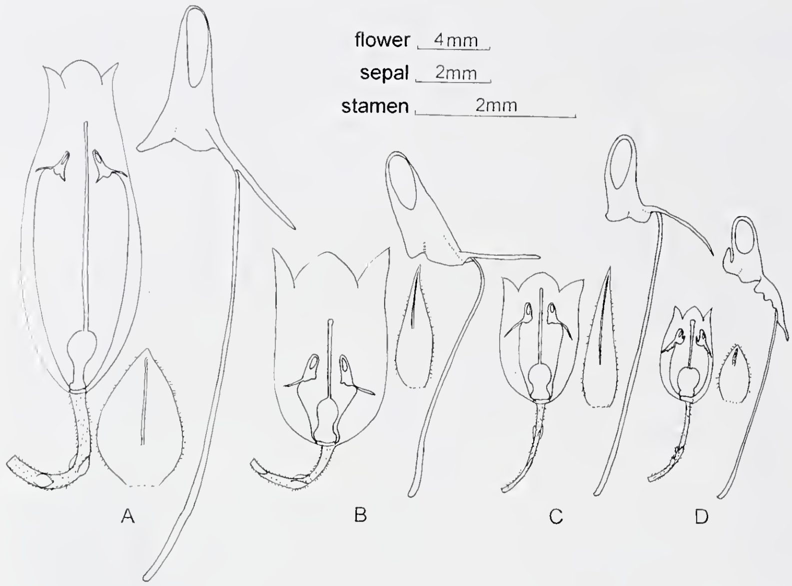

FIGURE 6.—Relationship of floral parts in A, *Erica penduliflora*; B, *E. filipendula* subsp. *filipendula*; C, *E. filipendula* subsp. *parva*; D, *E. globulifera*. Left, flower cut open longitudinally to show position of anthers; centre, sepal; right, stamen in side view showing variations in basal nose. Scale bars: flower, 4 mm; sepal, stamen, 2 mm.

Diagnostic features: sepals ovate, $^{1}/_{5}$–$^{1}/_{4}$ as long as corolla; anther appendages broadly based and much toothed; corolla purplish pink, 3–5 mm long.

The larger-flowered collections southwest of Bredasdorp have very reduced anther noses, whereas the collections from the De Hoop area have smaller flowers and remarkable turned-up noses, a character not found in any other species (Figure 6D).

Dulfer only examined the single collection, *Schlechter 10472* (W), when he raised *E. filipendula* var. *minor* to specific status and selected that as the lectotype, unaware that the other three syntypes constituted another distinct taxon (see 17b).

Vouchers: *Schlechter 10472* (BM!, BOL!, P!, SAM!, W).

17.2. **E. penduliflora** *E.G.H.Oliv.* in E.G.H.Oliv. & I.M.Oliv. in Yearbook of the Heather Society 2001: 31 (2001). Type: Western Cape, 3419DA, Bredasdorp Dist., hills NW of Viljoenshof, 120 m, 12 May 1999, white-flowered, *E.G.H. & I.M.Oliver 11245* (NBG, holo.; BM, BOL, K, MO, NY, P. PRE, S).

E. filipendula var. *major* Bolus: 56 (1905). Types: Syntypes: Bredasdorp Div., fairly abundant on downs between Elim and Ratel River, 300–600 ft [90–180 m], *Guthrie 3786* (BOL!, NBG!); ibid., *Bolus 8452* (BM!, BOL, NBG!, PRE); ibid., *Schlechter 7618* (BM!, BOL!, NBG!, P!, PRE, W), *Schlechter 7726* (BM!, BOL!, P!,W); ibid., *MacOwan* [Schlechter] *in Herb. Aust. Afr. 1920* (BM!, BOL!, P!, SAM!).

Illustrations: Baker & Oliver: t. 13 (1967); Schumann & Kirsten: 43, t. 11 (1992).

Diagnostic features: corolla 12–18 mm long; sepals broadly ovate; anthers with projecting nose and long thin appendages; ovary glabrous with long stipe. Figure 6A.

This was regarded as a large-flowered variety of *E. filipendula* by Bolus (1905), but was deemed sufficiently distinct to be recognized as a distinct species based on the above characters. The species has two distinct colour variants, white or yellowish green, which are allopatric. In the Pearly Beach area a white variant has recently been recorded with green tips.

Vouchers: *Oliver 11245* (BM!, BOL!, K!, MO!, NBG!, NY!, P!, PRE!, S!), *11246* (BM!, K!, NBG!, NY!, PRE!); *Schlechter 7618* (BM!, BOL!, NBG!, P!, PRE, W).

18. ***E. grandiflora*** L.f.—see *E. abietina* subsp. *aurantiaca* (23e).

19. ***E. exsurgens*** Andrews—see *E. abietina* subsp. *aurantiaca*. (23e).

20. ***E. longisepala*** Guthrie & Bolus: 57 (1905); Dulfer: 35 (1965). This is just a large-flowered form of *E. parilis* Salisb. (Guthrie & Bolus 1905: sp. no. 301).

21. **E. hibbertii** *Andrews*, Coloured engravings of heaths: t. 172 (1805) as *hibbertia*; Guthrie & Bolus: 58 (1905); Dulfer: 36 (1965). Type: Andrews: t. 172 (1805).

Note: see note under *E. banksii* (7) for the need to change Andrews' personal epithets.

Illustrations: Baker & Oliver: t. 18 (1967); Schumann & Kirsten: 44, t. 16, 17 (1992).

Diagnostic features: corolla smooth (lacking any longitudinal ridges), sticky; bract and bracteoles nearly as long as sepals and approximate to them; inflorescences umbel-like.

The inflorescence is umbel-like on the main stems and can have, in addition, below the umbel, short leafy branchlets ending with a 3- or 4-nate inflorescence. This latter situation is shown in Andrews' painting.

The main axis can sometimes continue growth.

Vouchers: *Bolus 5168* (BOL!, PRE); *Oliver STE30035* (BM!, K!, NBG!, PRE!), *11952* (K, NBG, NY, PRE); *Salter 4952* (BOL!, K!, SAM!).

21.1. ***E. tenax*** L.Bolus—see *E. thomae* (21.2).

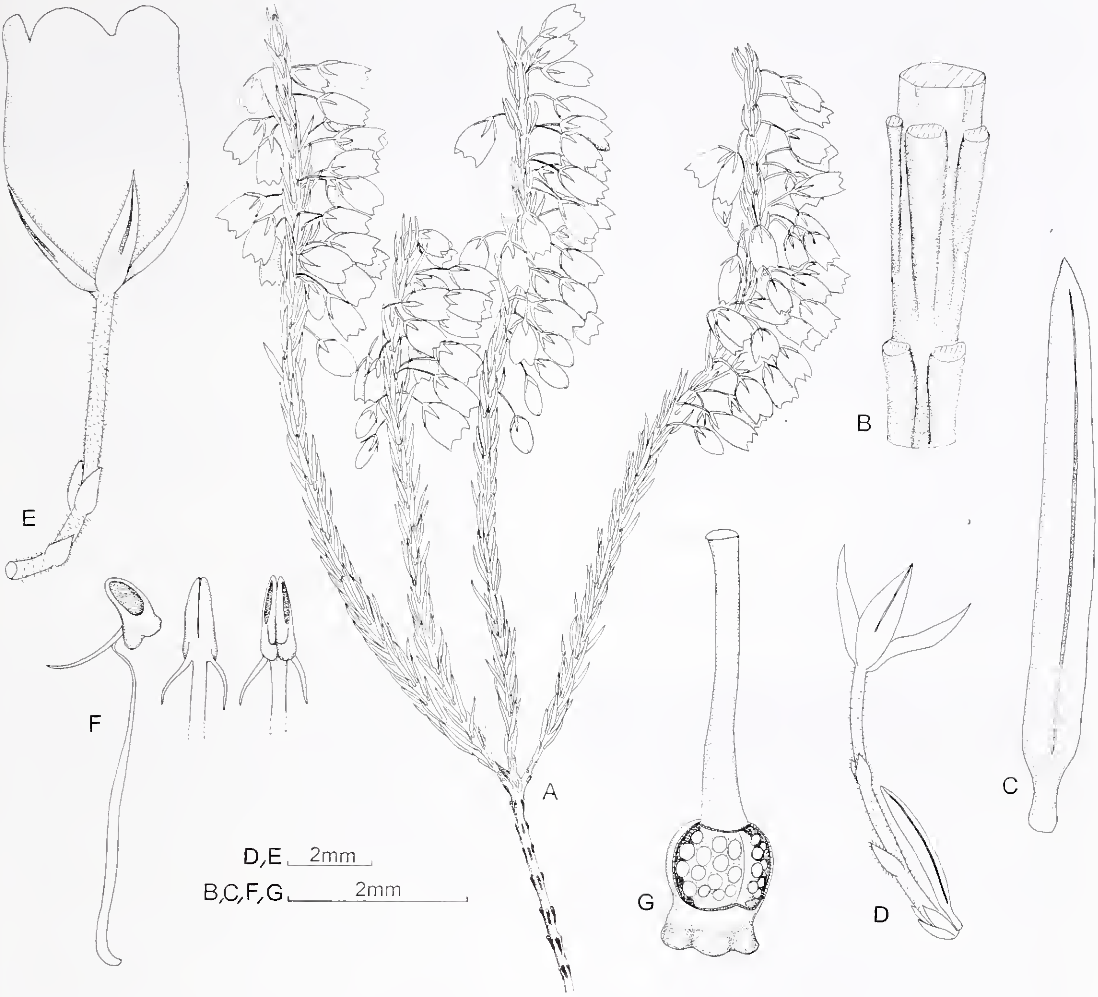

FIGURE 7.—*Erica filipendula* subsp. *parva*, type, *Oliver 11254*. A, flowering branch, × 1; B, stem with leaves removed; C, leaf; D, vestigial lateral branch in axil of vegetative leaf, showing vestigial leaves at base and flower with corolla removed; E, flower; F, anther, side, back and front views. Scale bars: B–G, 2 mm.

21.2. **E. thomae** *L.Bolus* in Annals of the Bolus Herbarium 4: 17, t. 1A (1925); Dulfer: 36 (1965). Syntypes: Cape Province, South-Western Region: Caledon Div., fl. Jan., Rooi Els near Hangklip, *T.P. Stokoe in BOL17571* (BOL! K!); Palmiet River Valley, *Stokoe in BOL17572* (BOL!). Lectotype selected here: *Stokoe in BOL17571* (BOL).

E. thomae L.Bolus var. *brevisepala* L.Bolus: 18 (1925). Type: Cape Town Wildflower Show, *sine coll. BOL16233* (BOL!).

E. tenax L.Bolus: 17, t. 1B (1925); Dulfer: 36 (1965). Type: Caledon Div., Palmiet River Valley, fl. Jan., *T.P.Stokoe in BOL17623* (BOL!, K!).

E. porteri Compton: 125, t.7 (1953); Dulfer: 36 (1965). Syntypes: Caledon Dist., Buffels Kloof, near Pringle Bay, 500 ft. alt., 25 March 1953, [specimen figured], *Porter s.n.* (NBG!); ibid., 25 March 1953, *Porter s.n.* (NBG!); ibid., 17 August 1953, *Porter s.n.* (NBG!).

Illustrations: L.Bolus: t. 1A (1925); Schumann & Kirsten: 44, t. 18; 45, t. 19–21 (1992).

Diagnostic features: corolla sticky, with longitudinal ridges, densely to sparsely covered with hair-like spicules or pustules; flowers in a dense spike-like synflorescence, with 1-flowered florescences on vestigial lateral branchlets bearing small scarious leaves; bract and bracteoles small, tough and situated in middle of pedicel; anthers included with ear-like appendages below thecae; filaments with spicule-like hairs; ovary rounded and glabrous.

We retain the epithet *thomae* in recognition of Thomas Stokoe's considerable collections of fynbos plants made from the 1920s to the early 1950s—both L. Bolus' species were described on the same page.

The species shows much variation in the size, thickness and degree of spreading of the leaves, the length of pedicels (from 4–16 mm long), and the colour and size of the flowers. There are no clear-cut discontinuities to warrant formal taxonomic rank and the three species have been grouped here as variants of a single species. All occur in the mountains from Kogelberg to Hangklip to Kleinmond. Some detailed molecular studies may help to elucidate the relationships between the variants.

VARIANT A (formerly *E. thomae sensu stricto*): medium-long pedicels, 6–10 mm long; corolla 22–30 mm

long, rose pink to dark reddish pink with or without paler tips. It occurs in the southwestern parts of the distribution range.

VARIANT B (formerly *E. tenax*): long pedicels, 13–16 mm long; corolla 22–30 mm long, green to white. This is the variant from the northern and eastern parts of the distribution range.

VARIANT C (formerly *E. porteri*): short pedicels, 4–7 mm long; corolla 20–25 mm long, more delicate and dark reddish pink with white mouth; leaves more spreading up to 90°. This is restricted to a single small population in the Buffelsrivier Valley near Pringle Bay where it grows with Variant A and appears to produce hybrids. However, some collections of Variant A from other areas possess similar small flowers, but not the bicoloured corolla. The Buffelsrivier population has plants more delicate than the other two variants.

Vouchers: *Oliver 92* (NBG!, PRE!); *Porter s.n.* (K!, NBG!), *sub PRE28592* (K!, PRE); *Stokoe 8347* (BOL!, NBG!, PRE).

21.3. ***E. porteri*** Compton—see *E. thomae* (21.2).

22. ***E. phylicifolia*** Salisb.—see *E. abietina* subsp. *atrorosea* (23b).

22.1. **E. nevillei** *L.Bolus* in Annals of the Bolus Herbarium 3: 172, t. 7B (1923); Dulfer: 37 (1965). Type: Cape Province: South-Western Region: Cape Peninsula, southwestern slopes of Noord Hoek Mountain, fl. Jan–Feb., *N.S. Pillans 4124* (BOL!, K!, NBG!).

Illustrations: Schumann & Kirsten: 46., t. 24 (1992); Oliver & Oliver: t. 12 (2000).

Diagnostic features: corolla tube with basal restriction zone; inflorescence spike-like and/or umbel-like and with no continuing apical growth; ovary emarginate, glabrous.

With the bipartite anthers and emarginate turbinate ovary, this species clearly belongs in the *E. abietina* group. It is a restricted endemic on the Cape Peninsula.

Vouchers: *Baker 612* (BM!, NBG!, PRE!); *Galpin 12531* (K!, P!, PRE); *Pillans 4124* (BOL!, K!, NBG!).

22.2. **E. quadrisulcata** *L.Bolus* in Annals of the Bolus Herbarium 3: 172, t. 7D (1923); Dulfer: 37 (1965). Type: Cape Province: South-Western Region: Cape Peninsula, neck between Signal Mountain and Zwartkop, Klaver Valley, near Simonstown, fl. Jan., *Pillans 3944* (BOL!, NBG!).

Illustrations: L.Bolus: t. 7D (1923); Schumann & Kirsten: 46, t. 25 (1992); Oliver & Oliver: t. 14 (2000).

Diagnostic features: ovary acute, glabrous; inflorescence umbel-like, not continuing with vegetative elongation.

The species is a very restricted endemic on the Cape Peninsula.

Vouchers: *Baker 852* (BM!, NBG!); *Galpin 12798* (K!, PRE); *Pillans 3944* (BOL!, NBG!).

23. **E. abietina** *L.*, Species plantarum edn 1, 1: 355 (1753); Salter: 634 (1951); Dulfer: 37 (1965). Type: this will be dealt with in a paper on Linnaean typification (Oliver, Jarvis & Cafferty, in prep.).

Diagnostic features: ovary emarginate, obovoid, covered with dense, short, retrorse hairs (Figure 8).

The considerable range of variation and lack of clear disjunctions have resulted in the reduction of several well-known species to subspecific rank and with two new taxa warranting only subspecific rank.

23a. subsp. **abietina**

E. coccinea sensu P.J.Bergius: 92 (1767), non L. (1753); Benth.: 627 (1839); Guthrie & Bolus: 59 (1905). Type: without locality or collector (SBT).

Illustrations: Schumann & Kirsten: 46, t. 26 (1992); Oliver & Oliver: t. 9 (2000).

Diagnostic features: corolla dark red, tubular, 18–26 mm long, spiculed to sparsely puberulous and slightly viscid; sepals subovate, sparsely pilose with adaxial sessile glands; anthers included to exserted (Figure 8B).

The subspecies is confined to the upper rocky slopes and plateau of Table Mountain.

Vouchers: *Bolus 3366* (BM!, BOL!, K!, PRE), *sub Herb. Norm. 189* (BM!, BOL!, P!); *Oliver 110* (NBG!).

23b. subsp. **atrorosea** *E.G.H.Oliv. & I.M.Oliv.*, subsp. nov., corolla rosea ad atrorosea, tubulosa, 18–22 mm longa, ± glabra aliquantum viscida, sepalis late lanceolatis, sparse puberulis glandibus adaxialibus, antheris inclusis interdum manifestis. Figura 8C.

TYPE.—Western Cape, 3418 (Simonstown): Froggy Pond, (–AB), 14 June 1949, *Barker 5355* (NBG).

E. purpurea Andrews, Coloured engravings of heaths: t. 50 (1795); Benth.: 627 (1839); Guthrie & Bolus: 58 (1905). Iconotype: Andrews: t. 50 (1795).

E. phylicifolia Salisb.: 364 (1802); Salter: 636 (1951); Dulfer: 36 (1965). Type: Sponte nascentem in Hottentots Holland, *I. Mulder s.n.* (K!). Note: the type has a finely puberulous calyx.

E. hesseana J.C.Wendl. ex Klotzsch: 634 (1835); Guthrie & Bolus: 61 (1905); Dulfer: 38 (1965). Type: Prom. b. sp., *Hesse s.n.* (MEL!). Note: there are two specimens in MEL—one the original from Wendland's herbarium determined by Klotzsch, the other a branch broken off by Klotzsch and retained in B and seen by Bentham. Both were borrowed by Sonder who was working on the genus for his *Flora capensis* when he died, and were never returned to the original herbaria. His herbarium was sold in two parts with the Ericaceae going to Baron Ferdinand von Mueller in MEL.

Illustration: Schumann & Kirsten: 45, t. 23 (1992).

Diagnostic features: corolla rose to deep rose, tubular, 18–22 mm long, ± glabrous and somewhat sticky; sepals broadly lanceolate, sparsely puberulous with adaxial sessile glands; anthers included, occasionally manifest (Figure 8C).

The taxon is confined to the Cape Peninsula and occurs from the lower slopes of Table Mountain at Kirstenbosch along the mountains southwards to Cape Point. It is not sympatric with subsp. *abietina*.

Paratype material (selection from numerous collections): WESTERN CAPE—3318 (Cape Town): Kirstenbosch, 150 ft [45 m], (–CD), 27-08-1997, *McGrath s.n.* (NBG!). 3418 (Simonstown): Muizenberg, 1400 ft [426 m], (–AD), 02-1878, *Bolus 4475* (BM!, BOL!, K!, PRE!); Muizenberg/Kalk Bay Mtns, 300 ft [90 m], (–AD), 03-1880, *Bolus 4516* (BM!, BOL!, K!, NBG!); St James, 900 ft [274 m], (–AD), 12-02-1959, *Oliver 50* (NBG!); Kalk Bay Mtn, 800 ft [243 m], (–AD), 12-02-1959, *Oliver 54* (NBG!); Swartkop, Klaver Valley, 1100 ft [335 m], (–AD), 14-02-1985, *Oliver 8675* (NBG!); Vasco da Gama Peak, (–CB), 12-12-1959, *Oliver 353* (NBG!); Cape Point, (–CB), 10-02-1929, *J.B. Gillett 3465* (NBG!); ibid., 06-1967, *Williams 1008* (NBG!).

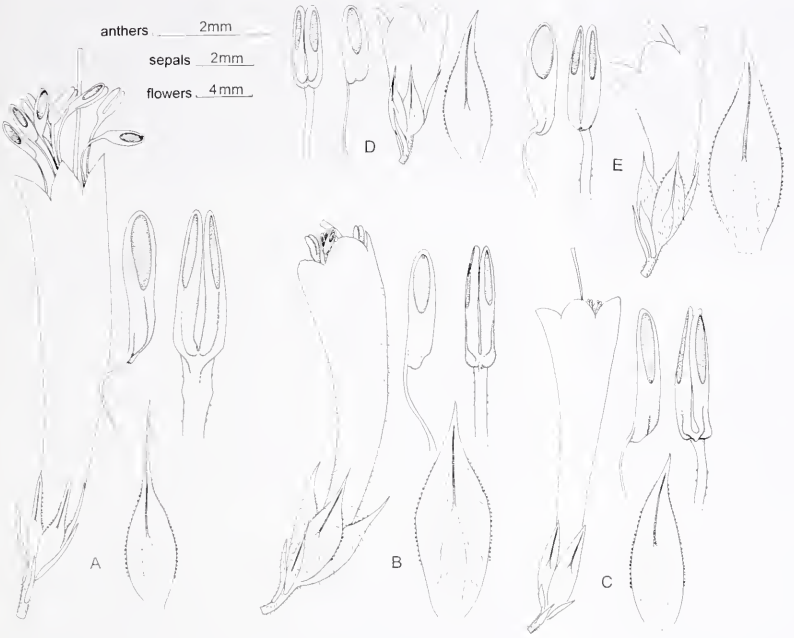

FIGURE 8.—*Erica abietina* complex. A, subsp. *aurantiaca*, *Van Wyk 481*, Rocklands, Cold Bokkeveld; B, subsp. *abietina*, *Taylor 5777*, Table Mtn, Platteklip; C, subsp. *atrorosea*, *Oliver 8675*, Simonstown; D, subsp. *constantiana*, *Oliver 11335*, Constantiaberg; E, subsp. *diabolis*, *Kirsten 422*, Devil's Peak Saddle. Scale bars: anthers, sepals, 2 mm; flowers, 4 mm.

23c. subsp. **diabolis** *E.G.H.Oliv. & I.M.Oliv.*, subsp. nov., corolla breviter obconica, rosea, 11–14 mm longa, subglabra, sepalis ovatis pilosis glandibus sessilibus adaxialibus dignoscenda. Figura 8E.

TYPE.—Western Cape, 3318 (Cape Town): saddle between Devil's Peak and Table Mountain, 2100 ft [640 m], (–CD), 25 August 1973, *Kirsten 422* (NBG).

E. coccinea L. var. *echiiflora* sensu Bolus: 60 (1905) non *E. echiiflora* Andrews. *E. abietina* var. *echiiflora* (Bolus) Salter: 643 (1951); Dulfer: 37 (1965).

Illustration: Schumann & Kirsten: 46, t. 27 (1992).

Diagnostic features: corolla shortly obconical, rose-pink, 11–14 mm long, subglabrous, subviscid; sepals ovate, pilose with adaxial sessile glands (Figure 8E).

The subspecies is a very restricted endemic occurring only on the saddle between Devil's Peak and Table Mountain.

Andrews' *E. echiiflora* is placed under *E. viscaria* subsp. *gallorum* (34d). His paintings show a ridged corolla with nipped-in mouth and spreading corolla lobes and an ovary with longish erect hairs—all typical of that species.

Vouchers: *Bolus 3772* (BM!, BOL!, K!); *Kirsten 422* (NBG!).

23d. subsp. **constantiana** *E.G.H.Oliv. & I.M.Oliv.*, subsp. nov., floribus obconicis, roseis, sepalis sparse puberulis vel glabris, antheris inclusis dignoscenda. Figura 8D.

TYPE.—Western Cape, 3418 (Simonstown): Constantiaberg, middle N slopes, 620 m, (–AB), 21-09-1999, *E.G.H. & I.M.Oliver 11335* (NBG).

E. conica Lodd.: t. 1179 (1824); Benth.: 664 (1839); Guthrie & Bolus: 60 (1905); Salter: 649 (1951); Dulfer: 37 (1965). Iconotype: Lodd.: t. 1179 (1824).

Illustrations: Schumann & Kirsten: 47, t. 28, 29 (1992); Oliver & Oliver: t. 10 (2000).

Diagnostic features: corolla pale to deeper rose-pink, obconic, 8–11 mm long, glabrous, subviscid; sepals lanceolate-ovate, with adaxial sessile glands; anthers always included, situated about $^2/_3$ way up tube (Figure 8D).

This subspecies is confined to the Cape Peninsula occurring on the mountains from Constantia Neck to Chapman's Peak.

Guthrie & Bolus (1905) noted that there is little to separate *E. conica* from subsp *diabolis* (quoted by them as *E. abietina* var. *echiiflora*). We retain it as a subspecies in this complex.

Paratype material (selection from numerous collections): 3318 (Cape Town): Kasteelspoort, 1200 ft [365 m], 08-1877, *Bolus 3715* (BOL!, K!); no precise locality, mtns near Cape Town, 1894, *Bolus 7949* (BOL!, NBG!, PRE). 3418 (Simonstown): Constantiaberg, 2000 ft [609 m], (–AB), 22-05-1941, *Compton 10842* (NBG!); ibid., 2900 ft [883 m], 5-06-1985, *Oliver 8742* (NBG!); ibid., 29-08-1963, *Stauffer 5063* (K!, NBG!, PRE); Orangekloof, (–AB), 28-08-1954, *Esterhuysen 23085* (BOL!); Chapman's Peak/Noordhoek, 900–1000 ft [274–304 m], (–AB), 1-08-1972, *Kirsten 304* (NBG!); Karbonkelberg, (–AB), 16-08-1972, *Oliver s.n.* (NBG!); Vlakkenberg, (–AB), 13-09-1936, *Salter 6283* (BOL!, K!); Noordhoek Peak, (–AB), 1400 ft [426 m], 20-07-1967, *Taylor 6395* (NBG!, PRE).

23e. subsp. **aurantiaca** *E.G.H.Oliv. & I.M.Oliv.*, subsp. nov., corolla (10–)25–30[–34] mm longa, glabra, viscida vel non viscida, sepalis longe acuminata ex base ovata, antheris inclusis ad perexertis. Figura 8A.

TYPE.—Western Cape, 3319 (Worcester): Fransch Hoek Pass, mtn slopes NE of top of pass, 2500 ft [760 m], (–CC), February 1966, *Chater in STE30037* (NBG, holo.; BM, BOL, K, PRE).

E. grandiflora L.f.: 223 (1782); Benth.: 628 (1839); Guthrie & Bolus: 57 (1905). Type: Caput bonae spei, *Thunberg s.n.* (UPS).

E. exsurgens Andrews, Coloured engravings of heaths: t. 22 (1796); Benth.: 627 (1839); Guthrie & Bolus: 57 (1905); Dulfer: 35 (1965); *E. grandiflora* var. *exsurgens* E.G.H.Oliv.: 204 (1967). Iconotype: Andrews: t. 22 (1796). Note: Andrews' paintings bearing the above names all seem to be of the Franschhoek/Wemmershoek form with longer leaves and pale to dark orange flowers, but not pure yellow.

Illustrations: Baker & Oliver: t. 14 (1967); Schumann & Kirsten: 44, t. 14 (1992).

Diagnostic features: corolla tubular, (10–)25–30[–34] mm long, glabrous, sometimes with few hairs on lobes, orange to orange-red, sticky to non-sticky; sepals long acuminate from ovate base, with large area of adaxial sessile glands; anthers included to far exserted (Figure 8A).

This is the most widespread, common and variable of the subspecies, occurring from the hills just northeast and east of Cape Town to as far inland as the Witteberg at Matjiesfontein and southeast to near Ashton, but absent from the Cape Peninsula. The flowers can be pale to dark orange with zones of yellow below, to completely deep orange-red.

Paratype material (selection from numerous specimens): WESTERN CAPE.—3318 (Cape Town): Klein Dassenberg, Kanonkop, (–DA), 3-05-1986, *Fellingham 1077* (NBG!); Kuils River hills, 600 ft [182 m], (–DC), 19-06-1972, *Oliver 3767a* (K!, NBG!, PRE). 3319 (Worcester): Agter Witsenberg, (–AB), 10-03-1959, *Barker 8875* (MO!, NBG!); Michell's Pass, 1 400 m, (–AD), 01-1892, *Guthrie 2285* (NBG!); ibid., 1200 ft [365 m], 15-01-1896, *Schlechter 9958* (BOL!, K!, NBG!, PRE!, W); Ceres, Waboomsberg, 1 320 m, (–AD), 12-11-1989, *Oliver 9272* (NBG!); Bokkerivier, (–BD), 9-11-1963, *Middlemost 2241* (NBG!, NY!); Du Toit's Kloof, foot Paarl side, (–CA), 15-10-1949, *Barker 6076* (NBG!, P!); Paarl, Donkerkloof, (–CC), 12-09-1948, *Esterhuysen 14560* (BOL!, NBG!); French Hoek, (–CC), 1894, *Fair sub Bolus 6321* (BOL!, NBG!, PRE); Fransch Hoek Pass, 920 m, (–CC), 8-01-1970, *Oliver & Palser 12* (NBG!, PRE). 3320 (Montagu): Touwsrivier, Pienaarspoort, 1 000 m, (–AA), 5-05-1994, *Oliver 10464* (NBG!); Remhoogte SE of Ashton, 425 m, (–CC), 21-03-1986, *Oliver 8814* (NBG!).

23f. subsp. **perfoliosa** *E.G.H.Oliv. & I.M.Oliv.*, subsp. nov., foliis longioribus 20–30(–42) mm, corolla flava dense puberula non viscida dignoscenda. Figura 9.

TYPE.—Western Cape. 3318 (Cape Town): Stellenbosch, Jonkershoek Twins, SW slopes, 600 m, (–DD), 24 May 2001, *E.G.H. & I.M.Oliver 11912* (NBG, holo.; BM, BOL, K, MO, NY, P, PRE, S).

Illustration: Schumann & Kirsten: 44, t. 15 (1992).

Diagnostic features: corolla pure yellow, 20–25 mm long, densely, finely hairy, non-sticky; sepals broadly elliptic and long acuminate, with adaxial non-sticky sessile glands; anthers included to manifest; leaves 20–30(–42) mm long (Figure 9).

The material of this taxon was at one stage classified as *E. exsurgens* Andrews. The taxon does not match any of Andrews' plates and is a distinct, very localized entity occurring only in the Jonkershoek Valley near Stellenbosch where it is occasional to locally common on the moister granitic slopes facing south and southwest.

Paratype material: WESTERN CAPE—3318 (Cape Town): all from Stellenbosch, Jonkershoek Valley, (–DD), 29-03-1943, *Esterhuysen 8789* (BOL!); 3-04-1949, *Esterhuysen 15230* (BOL!); 25-01-1975, *Esterhuysen 33758* (BOL!, K!); 19-05-1950, *Parker 4477* (BOL!, K!, NBG!); 2300 ft [700 m], 14-06-1962, *Taylor 3399* (BM!, NBG!, PRE); 3000 ft [914 m], 30-01-1963, *Taylor 4628* (NBG!, PRE); 13-04-1961, *Van Rensburg 465* (NBG!, PRE).

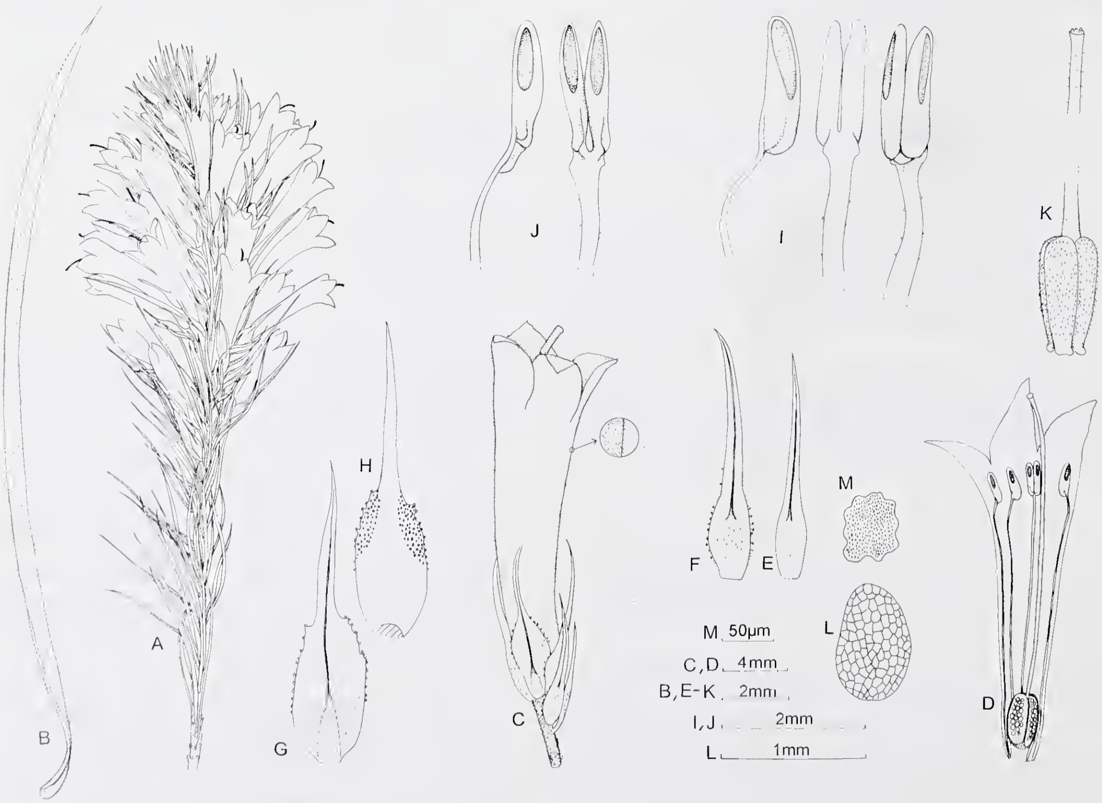

FIGURE 9.—*Erica abietina* subsp. *perfoliosa*, type *Oliver 11912*. A, flowering branch, × 1; B, leaf; C, flower; D, flower cut in half with sepals removed; E, bract; F, bracteole; G, sepal; H, sepal, adaxial surface showing sessile glands; I, anther, side, back and front views; J, anther variant, side and front views; K, gynoecium seed; M, testa cell. Scale bars: B, E–K, 2 mm; C, D, 4 mm; L, 1 mm; M, 50 µm.

23g. subsp. **petraea** *E.G.H.Oliv. & I.M.Oliv.*, subsp. nov., corolla flava dense puberula non viscida, sepalis sine glandibus sessilibus adaxialibus, habitu petrensis dignoscenda. Figura 10.

TYPE.—Western Cape. 3319 (Worcester): Porterville area, Groot Winterhoek Mtns, Kliphuisvlakte, road to Groot Kliphuis, rock crevices in rocky outcrop, 1 140 m, (–AA), 23 November 1999, *E.G.H. & I.M. Oliver 11440* (NBG, holo.; K, PRE).

Diagnostic features: corolla pure yellow, ± 20 mm long, densely, finely hairy, non-sticky; sepals narrow-lanceolate with no adaxial sessile glands; anthers manifest to exserted (Figure 10).

The subspecies is restricted to rocky outcrops on the mountains above Porterville where the common and widespread subsp. *aurantiaca* is not known to occur.

Paratype material: WESTERN CAPE.—3219 (Wupperthal): Groot Winterhoek Wilderness area, mtns above and ENE of Porterville, 3200 ft [975 m], (–CC), 23-11-1999, *E.G.H. & I.M. Oliver 11449* (BM!, NBG!).

Erica abietina is highly variable in flower size and colour, indumentum of calyx and corolla, stickiness of the corolla, degree of inclusion/exsertion of the stamens, anther shape, and leaf length and habitat preferences. It used to consist of four separate species that were long established in the literature—*E. abietina*, *E. phylicifolia*, *E. grandiflora* and *E. conica*. There are no clear disjunctions in the ranges of characters that were formerly used to separate them, but there are some slight discontinuities which warrant only subspecific recognition.

The whole complex is held together by flowers borne 1-nate or occasionally 2-nate on vestigial lateral branchlets arranged in compact, spike-like synflorescences towards the ends of main branches. The leaves are all apiculate and vary from 10–30(–42) mm long, the sepals vary from very narrow, long-lanceolate to lanceolate, to broadly lanceolate, to almost ovate and long-acuminate and have a flattened, raised area below the sulcus. They may be villous to pilose or glabrous and often bear numerous sessile glands over their inner surface, thus rendering the corolla viscid. The sepals all have sessile glands on the margins and, except for subsp. *petraea*, numerous sessile glands adaxially in the middle zone next to the margins (Figure 9H)—these may be sticky or non-sticky.

The corolla is mostly long-tubular varying from 18 to 30(–34) mm in length, but in two subspecies, obconical and only 8–14 mm long. It varies from glabrous to subglabrous to densely and finely hairy and may be red, orange-red, orange, deep pink, pink or yellow. In the fresh state these colours are very distinctive, and would clearly lead one to use them as specific characters, but in dried material without colour notes, identification is nigh impossible and one has to resort to a few morphological characters. The anthers can be distinctly bipartite, even splitting in the apex of the filament, to having the thecae closely adpressed—sometimes varying in a single collection. They are mostly attached basally to slightly subbasally. The filaments are often sparsely strigulose with the style sparsely hairy.

The Peninsula taxa tend to form a group having the apex of the corolla lobes a little more rounded, whereas the taxa from the mainland have more acute apices to the corolla lobes.

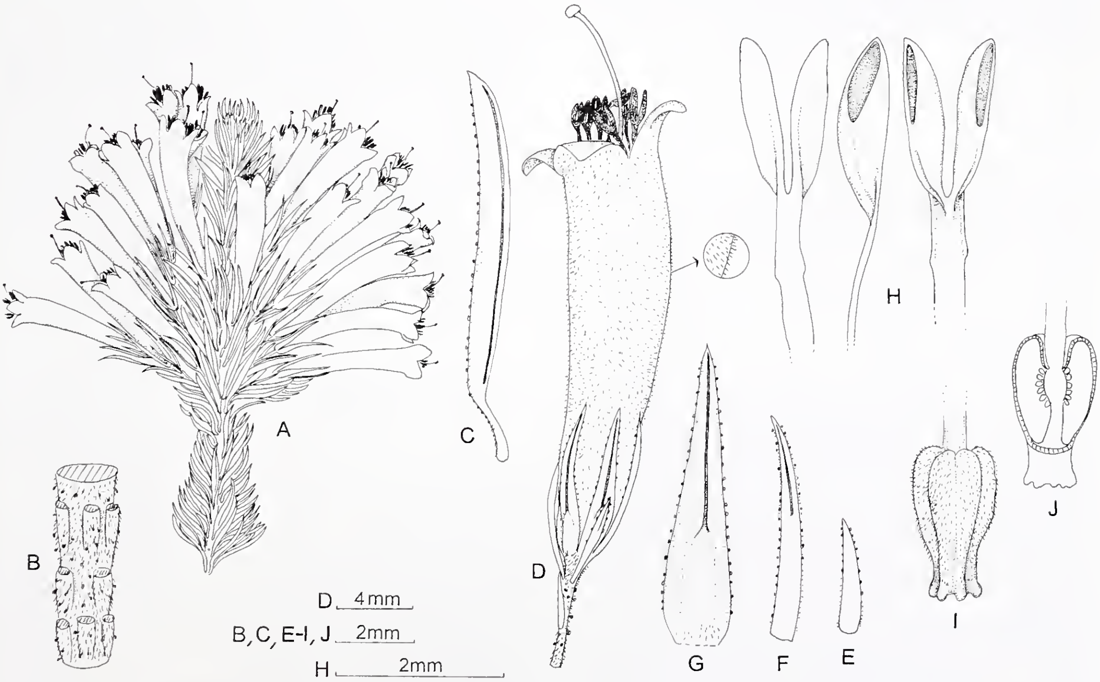

FIGURE 10.—*Erica abietina* subsp. *petraea*, type *Oliver 11440*. A, flowering branch, × 1; B, stem with leaves removed; C, leaf; D, flower; E, bract; F, bracteole; G, sepal; H, anther, back, side and front views; I, ovary; J, l/s ovary. Scale bars: B, C, E–J, 2 mm; D, 4 mm.

24. ***E. conica*** Lodd.—see *E. abietina* subsp. *constantiana* (23d).

25. **E. pinea** *Thunb.*, Dissertatio botanica de *Erica*: 23 (1785); Guthrie & Bolus: 60 (1905); Dulfer: 38 (1965). Type: sine loc., *Thunberg s.n.* (UPS; BM!, K!).

E. aurea Andrews, Coloured engravings of heaths: t. 76 (1803); Benth.: 628 (1839). Iconotype: Andrews: t. 76 (1803).

E. argentiflora Andrews, The Heathery: t. 202 (1809). *E. pinea* var. *argentiflora* (Andrews) Bolus: 61 (1905); Dulfer: 38 (1965). Iconotype: Andrews: t. 202 (1809).

E. aurea Andrews var. *viscosissima* Benth.: 628 (1839). *E. pinea* var. *viscosissima* (Benth.) Bolus: 61 (1905); Dulfer: 38 (1965). Type: Fransche Hoek Kloof, *Masson s.n.* (K!).

Illustrations: Schumann & Kirsten: 47, t. 30, 31 (1992).

Diagnostic features: corolla glabrous, smooth, dry; sepals with no glands on adaxial surface; ovary globose, substipitate, glabrous, 6–8-locular.

This species is characterized by the 6–8-locular ovary which is stipitate and glabrous, the glabrous dry smooth corolla and no glands on the adaxial surface of sepals. The flowers may be yellow with a white tip or pure white. It can easily be mistaken for white-flowered forms of *E. viscaria* subsp. *longifolia*.

Vouchers: *Esterhuysen 1769*, *19987* (BOL!, NBG!, PRE); *Oliver 1136* (NBG); *Schlechter 10254* (BM1, K!, NBG!, PRE); *Thompson 3834* (K!, NBG!, PRE).

26. ***E. hesseana*** J.C.Wendl. ex Klotzsch—see *E. abietina* subsp. *atrorosea* (23b).

27. **E. annectens** *Guthrie & Bolus* in Flora capensis 4: 61 (1905); Salter: 637 (1951); Dulfer: 38 (1965). Type: Cape Div., mountains near Kalk Bay, *Guthrie 1002* (BOL!, PRE).

Illustrations: Baker & Oliver: t. 16 (1967); Schumann & Kirsten: 48, t. 32, 33 (1992).

Diagnostic features: flowers 4-nate, terminal on branches; corolla glabrous, smooth, non sticky; anthers dorsally attached; ovary globose, glabrous, 8-locular.

This is a rare, highly restricted endemic on the Cape Peninsula. It is related to *E. pinea* and *E. verticillata* (64), which also have 8-locular ovaries.

Vouchers: *Oliver STE30036* (BM!, BOL!, K!, NBG!, PRE!).

28. **E. regia** *Bartl.* in Linnaea 7: 630 (1832); Benth.: 626 (1839); Guthrie & Bolus: 62 (1905); Dulfer: 38 (1965). Type: Zoutendaelsvalley im Distr. Caledon [Zoetendalsvlei near Agulhas], *Miss Joubert s.n.* (GOET?).

Diagnostic features: corolla glabrous and smooth, texture stiff and cartilaginous; anthers with vestigial appendages on apex of filaments; ovary hairy at top with erect hairs.

With only a slight disjunction in one morphological character coupled with a clear difference in habitat preferences, we are reducing this complex of three species and three varieties to one species with two subspecies.

28a. subsp. **regia**

E. regia var. *variegata* Bolus in Flora capensis 4: 62 (1905); Dulfer: 38 (1965). Syntypes: Bredasdorp Div., hills near Elim, 300–400 ft [90–120 m], *Pappe 60* (?); ibid., *Bolus 6754* (BM!, BOL!, K!, PRE); ibid., *Guthrie 2362* (BOL!); ibid., *Will sub MacOwan in Herb. Austr.-Afr. 1718* (BM!, BOL, K!, P!).

E. regia var. *williana* Bolus: 62 (1905); Dulfer: 38 (1965). Syntypes: Bredasdorp Div., hills near Elim, 300–400 ft [90–120 m], *Guthrie 3788* (NBG!); ibid., *Bolus 8448* (BM!, BOL!); ibid., *Schlechter 7680* (BM!, BOL!, PRE); ibid. *Will sub MacOwan Herb. Austr. Afr. 1719* (BM!, BOL!, K!, P!, SAM!). Lectotype selected here: *Will sub MacOwan Herb. Norm. Austr. Afr. 1719* (BOL!).

E. casta Guthrie & Bolus: 62 (1905); Dulfer: 38 (1965). Syntypes: Bredasdorp Div., maritime downs and hills near Elim, about 300 ft [90 m], *Guthrie 3719* (?); ibid. *Bolus 6752* (BM!, BOL!), *6762* (BOL!, K!) & *8446* (BM!, BOL!, K!). Note: *Bolus 6762* = *E. vestita* (31).

E. casta var. *breviflora* Guthrie & Bolus: 63 (1905); Dulfer: 38 (1965). Syntypes: Bredasdorp Div., hills near Elim, 300 ft [90 m], *Guthrie 3790* (BOL, SAM!); ibid. *Bolus 8449* (BOL!, K!), *8460* (BOL! K!). Note: *Guthrie's 3790* in SAM = *E. axilliflora* also *Bolus 8449* in BM. Bolus determined his *8449* in BOL as *E. axilliflora* and cites it as such in *Flora capensis*. He noted on the label of *8460* that it grew with his *8446* and *8449*. *Guthrie 3789* is *E. axilliflora* and cited as such in *Flora capensis*.

Illustrations: Baker & Oliver: t. 11 (1967); Schumann & Kirsten: 48, t. 34–37 (1992).

Diagnostic features: corolla nipped in at apex just below spreading lobes.

Guthrie & Bolus (1905) noted under *E. casta*—'closely allied to *E. regia*.....we propose the species with some doubt'. We concur with them.

The variant with variegated flowers (basal white zone, middle mauve/purple zone and bright red upper zone) is very striking and well known as the Elim Heath, but has no morphological differences from the unicoloured forms, some of which can have a slightly paler whitish basal portion.

The var. *williana* described by Bolus is a problem in that it was considered by us as a short-tubed form (flowers 6–12 mm long versus 14–20 mm in the typical subspecies) with a postulated different pollination syndrome and worthy of subspecific status. However, we have recorded it as a few plants growing together with the orange-red long-tubed typical subspecies and the dark pink *E. axilliflora* Bartl. just northwest of Zoetanysberg (see Note above under synonymy). The flowers varied from pale to darker purple. At the time we concluded that the plants were possible hybrids between the two species. Further 'populations' of this form need to be located and investigated thoroughly before any definite conclusions can be made as to its identity.

Vouchers: *Bolus 8448* (BM!, BOL!, K!, PRE); *Oliver 3371* (K!, NBG!, PRE), *3415* (K!, NBG!, PRE!), *STE30138* (K!, NBG! NY!, PRE!).

28b. subsp. **mariae** *(Guthrie & Bolus) E.G.H.Oliv. & I.M.Oliv.*, stat. et comb. nov.

E. mariae Guthrie & Bolus in Flora capensis 4: 63 (1905); Dulfer: 39 (1965). Type: Riversdale Div., at Milkwood Fontein, 600 ft [180 m], *Galpin 3565* (BOL!, K!, PRE).

Illustrations: Schumann & Kirsten: 50, t. 38–40 (1992).

Diagnostic features: corolla not nipped in at apex.

This subspecies occurs only on limestone ridges from southwest of Bredasdorp to Stilbaai. In the Mierkraal area this taxon grows on the limestone ridge, whereas the variegated variant of subsp. *regia* grows on the nearby lateritic/sandy flats.

Guthrie & Bolus separated the species in this variable complex on the colour and shape of the corolla and the

degree of protrusion of the nose at the base of the anthers.

The protologue for the species described the type with 'flores purpurei'. We have not seen a purple-flowered long-tubed plant in the wild, but have seen fresh material of the purple-flowered short-tubed form (var. *williana*). The Elim hills and Zoetanysberg possess a form with bright orange-red flowers and further south towards the sea the white-flowered (sometimes tinged pinkish) form, formerly *E. casta*, occurs, both on sandy substrates. On the lateritic flats southeast and east of Elim the form with variegated flowers occurs. On the limestone ridges from Mierkraal right through to Stilbaai, there occur plants with dark red flowers. The colours are very distinctive and recognizable, but have no major taxonomic significance to warrant subspecific ranking. Herbarium material in which colour has not been recorded cannot be identified with any certainty.

The corolla shape in *E. regia* and *E. casta* is almost identical, both having a restriction below the spreading corolla lobes and sometimes a tapering towards the base. The flowers of *E. mariae* do not have the distinct restriction. There is no clear-cut boundary between the more extreme anther noses in some material of *E. regia* to the almost lack of a nose in *E. casta* and *E. mariae*.

Vouchers: *Compton 23202* (NBG!, W); *Oliver 5788* (NBG!, PRE); *Taylor 8951* (K!, NBG!, PRE).

29. ***E. casta*** Guthrie & Bolus—see *E. regia* subsp. *regia* (28a).

30. ***E. mariae*** Guthrie & Bolus—see *E. regia* subsp. *mariae* (28b).

31. **E. vestita** *Thunb.*, Dissertatio botanica de *Erica*: 22 (1785); Benth.: 626 (1839): Guthrie & Bolus: 63 (1905): Dulfer: 39 (1965). Type: sine loc., *Thunberg s.n.* (UPS, K!, fragm.).

E. vestita var. *coccinea* Curtis: t. 402 (1798). E. *longifolia* Bauer var. *amplicata* Bolus: 66 (1905); Dulfer: 40 (1965). Type: Curtis: t. 402 (1798).

E. vestita var. *fulgida* Andrews: t. 137 (1804); Bolus: 64 (1905): Dulfer: 39 (1965). Iconotype: Andrews: t. 137 (1804).

E. longifolia Bauer var. *maritima* Bolus: 66 (1905); Dulfer: 40 (1965). Type: Bredasdorp Div., hills near Cape Agulhas, *Schlechter 10556* (BM!, BOL!, PRE!, W).

Illustrations: Baker & Oliver: t. 12 (1967); Schumann & Kirsten: 50, t. 41, 42 (1992).

Diagnostic features: long leaves with long petiole (i.e. versatile leaves); corolla trumpet-shaped, 16–24 mm long, finely hairy, not ridged; ovary hairy on top, hairs erect.

The variation in this species occurs in the shape of the sepals from narrow-lanceolate to those with a broader base, the corolla indumentum from very finely downy to pilose and flower colour—white, pink, purple to red. The northern groups of populations have distinctly geographical colours—white at Ezeljacht hills, red on the Riviersonderend Mountains and purplish pink on the Langeberg near Swellendam. They all have finely downy corollas, whereas the southern populations from the Klein River Mountains to Cape Agulhas have more pilose corollas. The population north of Stanford has white flowers, whereas there is a mixture of purple-pink to reddish in the colour of the flowers from the hills east of Stanford to Agulhas. The type is described as white-flowered and would probably match the Ezeljacht material.

Under *E. longifolia* Bolus commented on the close similarity between his var. *maritima* and *E. vestita*. We find it inseparable from the various forms of *E. vestita* found in the Bredasdorp District and transfer it as a synonym under this species—the smooth corolla (without ridges) being sparsely pilose and the long petioles making the leaves versatile, are the defining characters.

Vouchers: *Burchell 7949* (K!, P!, PRE); *Oliver 7536, 8982, 10970* (NBG!); *Schlechter 7634* (BM!, K!, P!, PRE, W).

32. **E. nematophylla** *Guthrie & Bolus* in Flora capensis 4: 64 (1905); Dulfer: 39 (1965). Syntypes: Riversdale Div., 1000 ft [300 m]; slopes of the Langeberg Range near Riversdale, *Schlechter 1728* (BM!, BOL!, K!, P!, Z); roadside, Garcia's Pass, *Galpin 3643* (BOL!, K!, PRE). Lectotype selected here: *Galpin 3643* (BOL).

E. filamentosa Andrews var. *longiflora* Bolus: 65 (1905); Dulfer: 40 (1965). Syntypes: Swellendam Div., mountain ridges along lower part of River Zondereinde, *Zeyher 3171* (BOL!, K!, P!, PRE, W); Caledon Div., without collector's name or number, Cape Govt. Herb. (?).

Illustrations: Schumann & Kirsten: 51, t. 43, 44 (1992).

Diagnostic features: corolla tubular, 10–12 mm long, narrowed slightly towards apex, finely hairy to subglabrous, white or pink.

The long-flowered variety of *E. filamentosa* has the closed corolla mouth of this species, and even though the corolla is pink, it is transferred to this species. There is a clear disjunction in the distribution range with the pink variant on the eastern Riviersonderend Range and the white variant on the Langeberg at Grootvadersbos and Garcia's Pass.

Vouchers: *Kirsten 677* (BOL!, K!, NBG!); *Oliver 8633* (NBG!); *Schlechter 1728* (BM!, BOL!, K!, P!, Z); *Zeyher 3171* (BOL!, K!, P!, PRE, W).

33. **E. filamentosa** *Andrews*, Coloured engravings of heaths: t. 91 (1804); Benth.: 664 (1839); Guthrie & Bolus: 65 (1905); Dulfer: 39 (1965). Iconotype: l.c., t. 91 (1804).

Note: Dulfer incorrectly dated Andrews' plates of this species—Coloured engravings of heaths: t. 91 is dated Feb. 1804 on the full painting, with the reduced version, The Heathery: t. 22, dated Feb. 1805 on the plate.

Illustration: Schumann & Kirsten: 51, t. 45 (1992).

Diagnostic features: corolla broadly obconic, 8–9 mm long, sparsely and very finely hairy, pink.

The species is confined to the gravelly flats southeast of Swellendam in the Bontebok National Park. It clearly has a different pollinator from the pink-flowered form of *E. nematophylla* as the anthers are situated lower down in the very open-mouthed corolla.

E. filamentosa var. *longiflora* Bolus is transferred to *E. nematophylla* (32).

Vouchers: *Kirsten 744* (BM!, NBG!); *MacOwan 1494* (K!, NBG!, PRE, W).

34. **E. viscaria** *L.*, Dissertatio botanica de *Erica*: 10 (1770); Andrews: t. 71 (1800); Benth.: 664 (1839); Guthrie & Bolus: 210 (1905); Salter: 649 (1950); Dulfer: 102 (1965). Lectotype: *Herb. Linn. no. 498.74*, lectotype selected here by Oliver, Jarvis & Cafferty, in prep.

Diagnostic features: corolla longitudinally ridged with very short bristle-like hairs or pustules; tube slightly constricted below spreading lobes, not or rarely obconical to broadly so; ovary obconical, not stipitate, covered with erect dense fairly long, white hairs (Figure 11).

This is a very variable species which occurs from the Cape Peninsula to Franschhoek and to the Bredasdorp coastal flats. It is probably the most variable species of *Erica* with respect to flower colour—white, green, yellowish, pink, purple, red, or combinations of pink with a white mouth or red with a yellow mouth. Some of these colour variants are very striking and showy. The corolla varies in shape and size over a wide range. The indumentum may be almost absent, finely puberulous, strigose, spiculate, strigose from pustules, or markedly pustulate. The flowers may be very viscid, partially so or non-viscid and the plants may be reseeders or resprouters with long to short leaves.

Colour is an unsuitable character since this is not retained by older herbarium material and can therefore not be used as a sole distinguishing feature.

Corolla length we regard as important in distinguishing subspecies, since the open corolla shape of these taxa coupled with a lower position of the stamens in their flowers would suggest a different pollination syndrome from the bird-pollinated long-flowered variants.

34a. subsp. **viscaria**

E. decora Andrews, Coloured engravings of heaths: t. 162 (1807); Benth.: 664 (1839); Salter: 649 (1950); Baker & Oliver: 119 (1967). *E. viscaria* L. var. *decora* (Andrews) Bolus: 211 (1905); Dulfer: 103 (1965). Iconotype: Andrews: t. 162 (1807).

Illustrations: Baker & Oliver: t. 114 (1967); Schumann & Kirsten: 169, t. 19 (1992).

Diagnostic features: inflorescence mostly lax; corolla short (5–9 mm long), urceolate to campanulate-obconic, soft and more transparent with slightly softer and shorter hairs; anthers often adhering laterally; thecae with more prominent basal bulges towards filament (Figure 11G).

Bolus (1905) noted the slight difference between subsp. *viscaria* and subsp. *gallorum* by describing *E. viscaria* var. *hispida* from the Sir Lowry's Pass area (see below under 34d). The inflorescence is mostly laxer and longer and the corolla soft and more transparent in the typical subspecies.

This subspecies occurs on the Cape Peninsula mountains and also the surrounding flats from where it is now mostly extinct except in the northern parts. Two variants occur—the commoner one with narrower, hairy sepals on the mountains and the rarer with broader, subglabrous sepals, as represented by the lectotype selected above, mostly on the flats.

Vouchers: *Baker 1228* (BM!, NBG!), *1773* (NBG!, PRE); *Bolus 4610* (BOL!, K!, NBG!, PRE); *Oliver 8683* (NBG!); *Steyn 88* (BOL!, NBG!); *Taylor 6404* (NBG!).

34b. subsp. **longifolia** *(Bauer) E.G.H.Oliv. & I.M.Oliv.*, comb. et stat. nov.

E. longifolia Bauer, Delineations of exotick plants cultivated in the royal garden at Kew: t. 4 (1796); Benth.: 625 (1839); Guthrie & Bolus: 65 (1905); Dulfer: 40 (1965). Iconotype: Bauer: t. 4 (1796). Note: the plate was dated 1 Jan 1793 by the artist/engraver, but published in the fascicle, part 1, dated April 1796 (see Britten 1899).

E. pinea J.C.Wendl.: 1, t. 11 (1798), non Thunb. (1785). *E. longifolia* var. *contracta* Bolus: 66 (1905); Dulfer: 40 (1965). Type: J.C.Wendl.: t. 11 (1798).

E. longifolia var. *squarrosa* Bolus: 66 (1905); Dulfer: 41 (1965). Syntypes: sine loc., *Bolus 8039* (BOL!) & *Schlechter 4789* (BM!, BOL!, NBG!, W).

E. longifolia var. *stricta* Dulfer: 41 (1965). Type: Caledon Distr.; Palmiet Rivier, *Schlechter 7326* (BM!, BOL!, W).

Illustrations: Baker & Oliver: t. 15 (1967); Schumann & Kirsten: 52, t. 47 (1992).

Diagnostic features: corolla ± 12–20 mm long, tubular, non-viscid, hairy or pustulate, red, pink, purple, white, yellowish or green or, in some cases, bicoloured—pink with a white mouth or red with a yellow mouth; sepals, bract and bracteoles long, linear-lanceolate (Figure 11A, B).

This is the most variable subspecies, which it may, on more detailed population studies coupled with molecular analyses, be possible to divide into more subspecific taxa. All plants appear to be single-stemmed reseeders.

There are problems in distinguishing material of the pink/purple-flowered form in the Bredasdorp District from similarly coloured forms of *E. vestita*. It is very possible that the two species hybridize where they are sympatric. The flowers of *E. viscaria* subsp. *longifolia* have a longitudinally ridged corolla and do not possess the longer, soft hairs of *E. vestita*.

E. longifolia var. *maritima* Bolus has been transferred to *E. vestita* (31).

Vouchers: *Burchell 8039* (K!, NBG!, P!, W); *Oliver 4175* (BM!, K!, NBG!, PRE!), *STE30038* (BOL!, K!, NBG!, PRE!); *Schlechter 4789* (BM!, BOL!, NBG!, W); *Zeyher 3172* (BOL!, NBG!, P!, PRE, W).

34c. subsp. **macrosepala** *E.G.H.Oliv. & I.M.Oliv.*, stat. et nom. nov.

E. glutinosa Andrews, Coloured engravings of heaths: t. 25 (1798), non P.J.Bergius (1767). Iconotype: Andrews: t. 25 (1798).

E. onosmiflora Salisb.: 363 (1802); Benth.: 626 (1839); Guthrie & Bolus: 66 (1905); Dulfer: 41 (1965). Type: as for *E. glutinosa* Andrews.

E. viridis Andrews: t. 140 (1805). *E. longifolia* var. *viridis* (Andrews) Bolus: 66 (1905); Dulfer: 41 (1965). Type: Andrews: t. 140 (1805).

Diagnostic features: sepals lanceolate to ovate-lanceolate, often with a broader base and attentuated apex, corolla ± 15–20 mm long, tubular (Figure 11D).

The corolla is yellowish to green, occasionally white and the plants are mostly resprouters. Some variants may have very viscid flowers. The subspecies occurs in the region from Betty's Bay to Elim.

Vouchers: *Compton 6135, 6149* (NBG!); *Esterhuysen 4949* (BOL!, NBG!); *Hugo 1541* (NBG!, PRE); *I. Kruger 1026* (NBG!); *Oliver 3351, 4202, 7423, 8700* (NBG!).

34d. subsp. **gallorum** *(L.Bolus) E.G.H.Oliv. & I.M.Oliv.*, stat. et comb. nov.

E. gallorum L.Bolus in Annals of Bolus Herbarium 1: 155, t. 11A (1918); Dulfer: 41 (1965). Type: Cape Province: South-Western Region, French Hock, fl. Oct., *Anon. in BOL14029* (BOL!, K!, PRE).

E. echiiflora Andrews: t. 164 (1805). Iconotype: Andrews: t. 164 (1805).

E. echiiflora Andrews var. *purpurea* Andrews: t. 260 (?1812). Iconotype: Andrews: t. 260 (1812).

E. viscaria L. var. *hispida* Bolus: 211 (1906). Syntypes: Stellenbosch Dist., mountains near Sir Lowry's Pass, 900 ft [274 m], *Bolus 5548* (BOL, K!, NBG!, SAM!); ibid., *Guthrie 3524* (BOL).

Illustrations: L.Bolus, t. 11A (1918); Schumann & Kirsten: 52, t. 49 (1992).

Diagnostic features: corolla short 5–10(–12) mm long, elongate-campanulate to obconic with pink lower half and white mouth or sometimes pinkish throughout; hairs short and stout (Figure 11F).

The subspecies is confined to the Nuweberg Reserve, Elgin, on the eastern and southeastern side of the Hottentots-Holland Mountains where the red-flowered form of subsp. *longifolia* occurs at higher altitudes.

Andrews' *E. echiiflora* is included as a synonym based on the ridged corolla with spreading to reflexed lobes and the ovary with erect, fine hairs, which are all characteristic of *E. viscaria* and not of *E. abietina*.

Vouchers: *Anon. in BOL14029* (BOL!, K!, PRE); *Kirsten 546* (NBG!); *Stokoe 7851* (BOL!, NBG!, PRE).

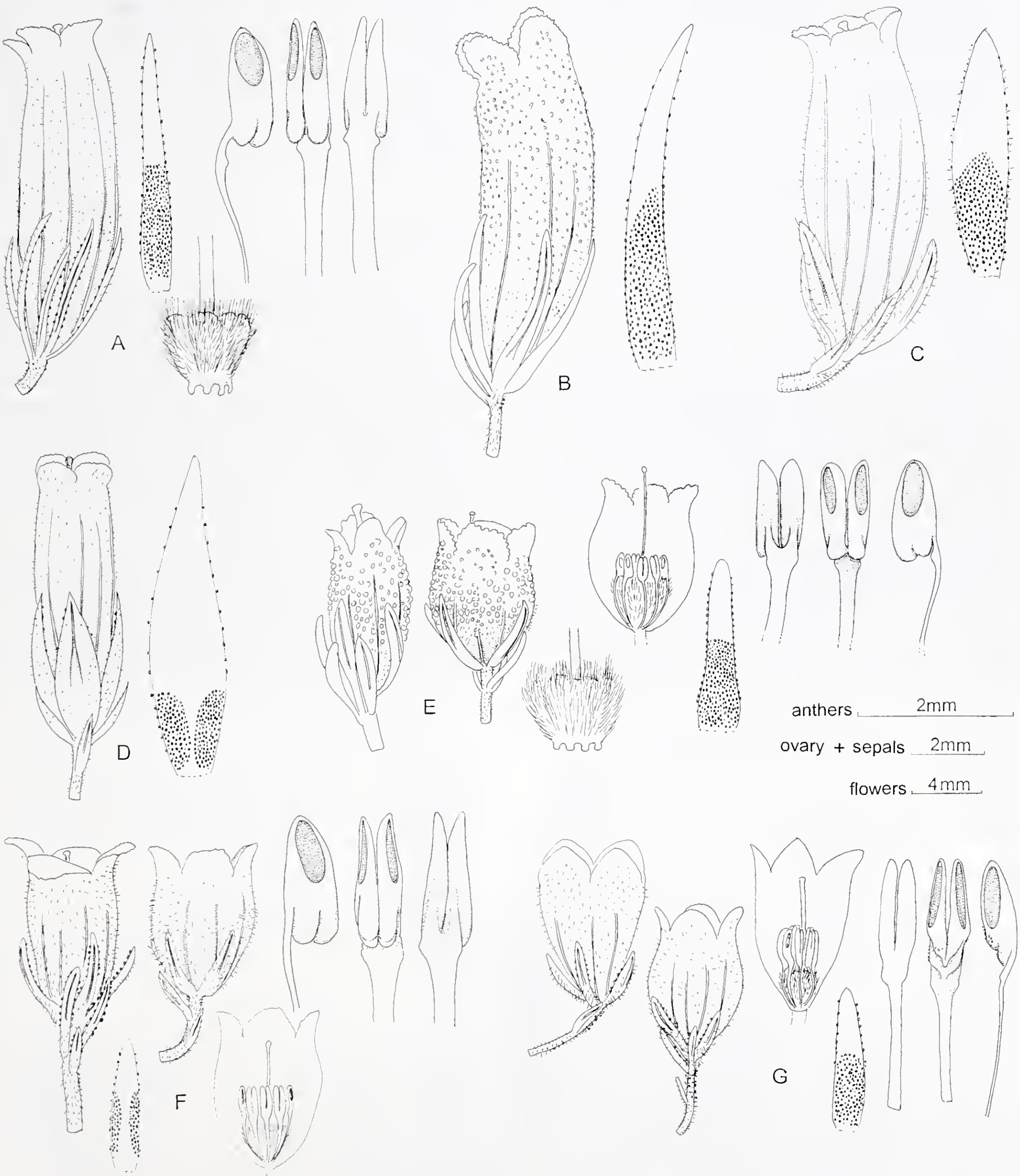

FIGURE 11.—*Erica viscaria* complex with flowers, sepal in adaxial view showing zones of sessile glands, anther and ovary. A, B, subsp. *longifolia*: A, *Oliver 11473*, Steenbras; B, *Gillett 999*, Hermanus. C, subsp. *pendula*, *Oliver 7610*, Highlands; D, subsp. *macrosepala*, *Porter s.n.*, Hangklip; E, subsp. *pustulata*, *Williams 1552*, Hermanus; F, subsp. *gallorum*, *Kirsten 546*, Nuweberg; G, subsp. *viscaria*, *Oliver 8683*, Simonstown. Scale bars: anthers, ovaries, sepals, 2 mm; flowers, 4 mm.

34e. subsp. **pustulata** *(H.A.Baker) E.G.H.Oliv. & I.M.Oliv.*, stat. et comb. nov.

E. pustulata H.A.Baker in Journal of South African Botany 39: 207 (1973). Type: Cape, 3419 (Caledon): above the dams on Mossel River at Hermanus, (–AC), at about 609 m, 11-10-1971, *Williams 1552* (BOL!, holo.; NBG!).

E. patersonii L.Bolus: 134 (1928), non *E. patersonia* Andrews. *E. longifolia* var. *breviflora* Dulfer: 40 (1965). Type: Caledon Div., Hermanus, fl. Sept. 1926, *Paterson in BOL18548* (BOL!).

Diagnostic features: corolla markedly pustulate, yellow, ± 7 mm long, ovoid-urceolate (Figure 11E).

Subsp. *pustulata* is closely related to the long-tubed form of subsp. *longifolia* with yellowish to green flowers from the same locality.

Vouchers: *Paterson in BOL18548* (BOL!, K!); *Williams 1552* (BOL!, NBG!).

34f. subsp. **pendula** *E.G.H.Oliv. & I.M.Oliv.*, subsp. nov., floribus pendulis albis non viscidis tubo corollae sub ore constricto ± 12–18 mm longo dignoscenda. Figura 11C.

TYPE.—Western Cape: 3419 (Caledon): Paardeberg, south of Highlands Forest Reserve, (–BC), 550 ft [150 m], 26 February 1980, *Oliver 7610* (NBG).

Illustration: Schumann & Kirsten: 52, t. 50 (1992) sub *E. onosmiflora*.

Diagnostic features: flowers pendulous (not spreading to semi-erect); corolla ± 12–18 mm long, tubular, white, sometimes tinged pink, non-sticky, with short hairs only along longitudinal ridges and around base; plants sparsely branched and up to 1.5 m tall, with relatively short grey-green leaves (Figure 11C).

This subspecies is confined to the eastern end of the Paardeberg Range west of Bot River Village.

A few collections from the region of Shaw's Mountain (e.g. *Oliver 8022*) have semi-pendulous flowers with the corolla red and a yellow mouth, but sticky and strigose. These could possibly be included under this subspecies, but further investigations need to be done to assess their identity within this highly variable species.

Paratype material: WESTERN CAPE.—3419 (Caledon): Arieskraal, (–AA), 17-11-1944, *Compton 9021* (NBG!); ibid., 255 ft [78m], 13-02-1993, *Rhode & Boucher 22* (NBG!); Paardeberg /Highlands, 800 ft [240 m], (–AC), 25-02-1970, *Boucher 1151* (K!, NBG!); ibid., 1000 ft, 22-03-1971, *F.J. Kruger 1176* (NBG!); ibid., 550 ft [167 m], 12-01-1970, *Oliver & Palser 67, 69* (NBG!); ibid., 150 m, 3-1985, *Schumann 307* (NBG!); ibid., 3-1949, *Stokoe s.n.* (SAM!); Houtech, SW of Houhoek, 1700 ft [578 m], (–AC), 17-09-1987, *Oliver 9021* (NBG!); Shaw's Mtn, above Langhuis, 300 m, (–AD), 2-08-1983, *Oliver 8022* (NBG!). Without precise locality (3418BB/3419AA): Palmiet/Grabouw, 800 ft [240 m], 20-07-1895, *Guthrie 4971* (NBG!); ibid., foothills, 10-1948, *Stokoe s.n.* (SAM!); road from Sir Lowry's Pass to Houwhoek, 6-04-1892, *Guthrie 2294* (NBG!).

The var. *amplicata* of *E. longifolia* described by Bolus (1905: 66) and upheld by Dulfer (1965: 40), was based on a coloured painting of *E. vestita* var. *coccinea* Curtis: t. 402 (1798). This plate does not depict any long-tubed subspecies of *E. viscaria* and is clearly the red-coloured form of *E. vestita* (31).

34.1. ***E. gallorum*** L.Bolus—see *E. viscaria* subsp. *gallorum* (34d).

34.2. **E. petrusiana** *E.G.H.Oliv. & I.M.Oliv.*, sp. nov., *Ericae viscariae* L. affinis sed corolla breve infundibuliformi-obconica, ± 8.5 × 5.0 mm, porcis longitudinalibus, subglabra, subviscida, obscure flava, lobis erectis et *Ericae latiflorae* L.Bolus sed lobis corollae brevioribus 1.2 mm longis, coloris corollae flava non purpurea distinguitur. Figura 12.

TYPE.—Western Cape, 3418 (Simonstown): Kogelberg area, between Steenbras River and Kogelberg, ± 1000 ft [± 300 m], (–BB), 16 March 1969, *Esterhuysen 32128* (BOL, holo.; NBG, K, PRE).

Erect low woody shrubs. *Branches*: numerous main branches ± 30–50 mm long with continuous apical growth, secondary branches few, very reduced, bearing a subterminal flower; internodes ± 1 mm long; stems covered with very short, dense, stiff, spreading hairs and occasional short-stalked glands. *Leaves* 4–6-nate, 8–12 mm long, erect, incurved, shortly acute, finely hairy to

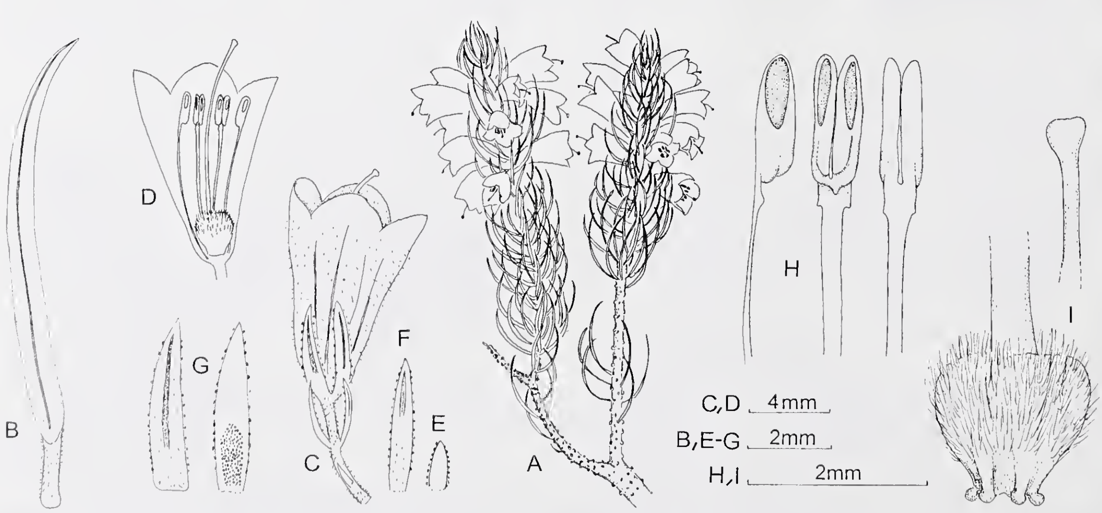

FIGURE 12.—*Erica petrusiana*, type *Esterhuysen 32128*. A, flowering branch, × 1; B, leaf; C, flower; D, flower opened laterally; E, bract; F, bracteole; G, sepal, abaxial view (left), adaxial view (right); H, stamen, side, front and back views; I, gynoecium. Scale bars: B, E–I, 2 mm; C, D, 4 mm.

glabrous on both sides, sulcus narrow, closed at base; petiole ± 18 mm long, puberulous. *Inflorescence*: 1 flower subterminal on very short, secondary branches at each node, all aggregated into a spike-like synflorescence, ± 15–20 mm long, towards ends of main branches, flowers suberect to spreading; pedicel ± 6 mm long, indumentum like stem; bract partially recaulescent ± $^1/_4$ way up pedicel, lanceolate, ± 1 mm long, glabrous, ciliate with sessile glands, esulcate; bracteoles about $^1/_2$ way up pedicel, linear-lanceolate, ± 3 mm long, finely hairy and ciliate with sessile glands, green, sulcate for $^1/_3$ their length. *Calyx* 4-partite; segments adpressed to corolla, lanceolate, ± 4.0 × 0.8 mm, abaxially finely hairy, adaxially with a basal, central zone of sessile sticky glands, sulcate for $^3/_4$ their length. *Corolla* 4-lobed, funnel-shaped-obconic, widest at mouth, longitudinally ridged, sparsely strigulose, dull yellow; lobes ± 1.2 × 3.5 mm, erect, margins entire. *Stamens* 8, free, included just below mouth; filaments straight, glabrous, with vestigial appendages just below thecae; anthers bilobed, oblong in adaxial view, thecae oblong in lateral view, ± 1.5 × 0.5 mm, smooth, pore $^1/_2$ length of theca; pollen in tetrads. *Ovary* 4-locular, broadly obovoid, ± 1.8 ×1.8 mm, emarginate, densely hairy with thick erect hairs, with basal nectaries; style exserted, glabrous; stigma capitate. Figure 12.

Diagnostic features: corolla shortly funnel-shaped/obconic with an open mouth, ± 8.5–5.0 mm long, longitudinally ridged, dull yellow, almost glabrous (only a few minute stiff hairs) with no pustules, slightly sticky, not nipped in below mouth, lobes erect, not spreading (Figure 12).

Erica petrusiana is closely related to the short-tubed subspecies of *E. viscaria*, but differs in the shape of the corolla with its open mouth. It shares this character with *E. latiflora* L.Bolus (303.1) which has an even more open corolla with longer lobes. This latter relationship points to the problem in the genus of the long-tubed and short-tubed species being closely related, but placed very far apart in the current sectional system.

The name is derived from the generic name of the fish, *Petrus rupestris*, the 'red steenbras' (red rock-bream), after the locality, the Steenbras area which is the type and only known locality. Esterhuysen records the plants as very local, but common, in stony shaly soil and also on sandstone ridge. She also records 'corolla was yellow, not very bright, but certainly yellow, slightly sticky'.

35. ***E. onosmiflora*** Salisb.—see *E. viscaria* subsp. *macrosepala* (34c).

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INDEX TO SPECIES

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Notes on African plants

HYACINTHACEAE

A NEW COMBINATION IN *DAUBENYA*

The circumscription of the genus *Daubenya* has recently undergone substantial modification as a result of phylogenetic analysis of plastid DNA sequence data (Goldblatt & Manning 2000; Van der Merwe *et al.* in prep.). The genus now includes the previously monotypic genera *Amphisiphon* and *Androsiphon*, as well as the taxa previously recognized in the genus *Neobakeria*. These various genera were distinguished from one another primarily on the basis of floral differences that are now understood to be related to different pollination strategies. Despite the exaggerated effect that these floral specializations have on the appearance of the plants, the species accord perfectly in vegetative morphology. The genus is characterized by the two prostrate or spreading leaves, glabrous and rather glossy above with impressed longitudinal striations along the main veins, with sheaths that split vertically on drying to form a neck of papery strips. The subcorymbose or racemose inflorescence develops small or medium-sized bracts subtending white to yellow or red flowers with a narrow perianth tube. In a few species the upper bracts are larger than the lower and form a ± conspicuous sterile coma at the tip of the inflorescence.

Among the taxa recently transferred to *Daubenya* (Goldblatt & Manning 2000) was the species known until then as *Massonia angustifolia* L.f. This species was described by the younger Linnaeus in 1782, based on the collections and notes of Thunberg. No specimen was designated as the holotype and although the description is too brief to be diagnostic in any way, his account of the species which appeared in *Hortus kewensis* (Aiton 1789) a few years later, is accompanied by a fine engraving (Figure 1). Thunberg's own description of the species appeared after Linnaeus' under the name *Massonia lanceolata* Thunb. The latter name was lectotypified by Jessop (1976), based on *Thunberg s.n.* (*UPS-THUNB7990*) and the same collection was later also designated as the lectotype of *Massonia angustifolia* L.f. by U. & D. Müller-Doblies (1997).

As understood in recent revisions of the group (Jessop 1976; Müller-Doblies 1997), *Massonia angustifolia* was readily distinguished from other species of *Massonia* by its relatively smaller bracts, cucullate tepals and orange filaments (Figure 2). These small bracts are characteristic of the group of species previously segregated as *Polyxena* subgenus *Astemma* (Baker 1896) and later as the genus *Neobakeria* (Schlechter 1924; Phillips 1951). In contrast, all species of *Massonia s. str.* have uniformly white or pinkish flowers that are subtended by large, leafy bracts and the infructescences are invariably subglobose on account of the highly condensed, corymbose inflorescence typical of the genus. In addition, the tepals in true species of *Massonia* display a highly characteristic orientation not found in other genera in the family. Initially reflexed from the base, they then curve outwards more or less abruptly, forming a sigmoid fold. Even a cursory look at the engraving of *M. angustifolia* published in *Hortus kewensis* reveals that the plant depicted has the large bracts characteristic of true *Massonia* species plus a clear indication of a sigmoid curvature in the tepals. It is clear, therefore, that this illustration does not coincide with the concept of *Massonia angustifolia* as understood by recent authors (Jessop 1976; Müller-Doblies & Müller-Doblies 1997; Goldblatt & Manning 2000).

Among the specimens in the Thunberg herbarium are only two sheets labelled *M. lanceolata*, one of them the lectotype of both *M. lanceolata* and *M. angustifolia*. This sheet (*UPS-THUNB7990*) bears two complete flowering

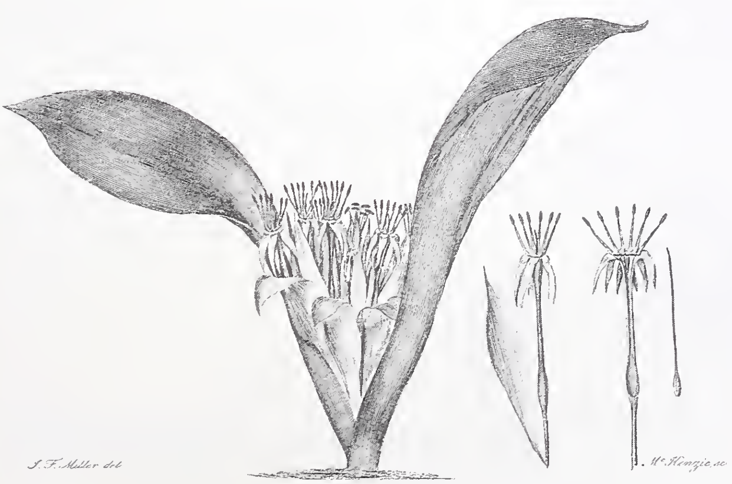

FIGURE 1.—*Massonia angustifolia* L.f. from *Hortus kewensis* (Aiton 1789).

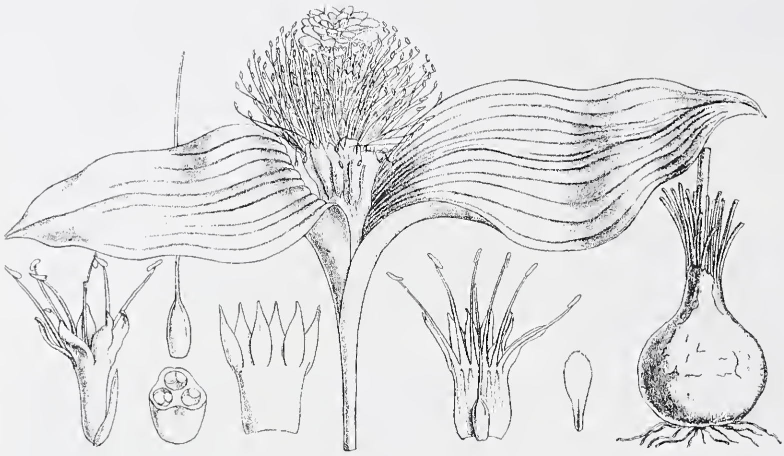

FIGURE 2.—*Daubenya marginata* (Willd. ex Kunth) J.C.Manning from *Hooker's Icones Plantarum* (1888) (as *Polyxena haemanthoides* Baker).

specimens plus three separate infructescences lacking both leaves and bulbs. The other sheet (*UPS-THUNB7989*) bears three flowering plants only. The flowering plants on both sheets match the illustration of *M. angustifolia* perfectly, but the fruiting stems on the lectotype are clearly not from the same species as they are rather more racemose with small floral bracts. It is quite clear that both Linnaeus and Thunberg were referring to the leafing and flowering material in their concept. The fruiting stems must therefore be excluded from the lectotype material. The type collection of *M. angustifolia* was made by Thunberg along the Roggeveld Escarpment in November 1774. All species of *Massonia* and *Daubenya* are winter-growing and winter-flowering, and at that time of the year the plants would have been in fruit. Thunberg was accompanied on this journey by the Scottish plant collector Masson, who had been sent out to South Africa to collect plants for the Royal Botanic Gardens at Kew. It was Masson's collections, received at Kew in 1775 and later flowered there, that formed the basis for the engraving of *M. angustifolia* that appeared in *Hortus kewensis* in 1789, and subsequently for a later illustration in *Curtis's Botanical Magazine* (Ker Gawler 1804). It is almost certain, therefore, that the fruiting bulbs collected by the men in November were similarly flowered in cultivation to provide the flowering material for the Thunberg herbarium, probably in the garden that they established in Cape Town for growing their collections. One can only surmise that Thunberg unwittingly combined flowering plants of the one species with previously collected fruiting specimens of a second species.

This raises the question of the true identity of *Massonia angustifolia*. There is no doubt that the species is actually a smooth-leaved form of *M. echinata* L.f. This species is common along the Roggeveld Escarpment and is extremely variable in leaf vestiture, even within populations. It is characterized in the genus by its narrowly tubular flowers with relatively short stamens and tepals with a sigmoid fold (Figure 3). The sole anomaly in this identification is the extremely long perianth tube depicted in the engraving in *Hortus kewensis* (Figure 1). This long tube is not, however, matched by the Thunberg herbarium material and must represent either an abnor-

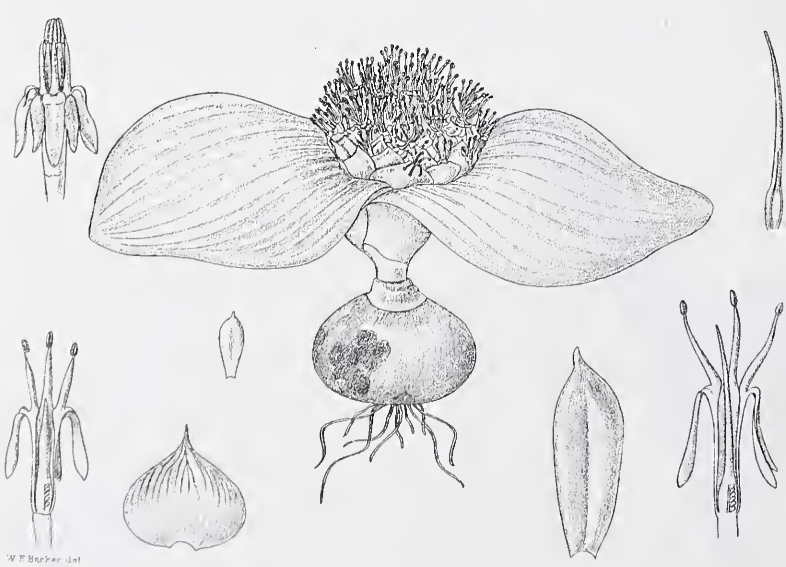

FIGURE 3.—*Massonia echinata* L.f. from *The Flowering Plants of South Africa* 11: t. 429 (as *M. bolusiae* W.F.Barker).

mality resulting from etiolation of the cultivated plants grown under low light intensity or, more probably, a misrepresentation by the artist who incorrectly identified the junction between flower and pedicel. *M. angustifolia* and *M. echinata* were both described contemporaneously by Linnaeus. The latter is a well-known species and *M. angustifolia* is therefore best placed into synonomy under *M. echinata*. The oldest available name for the plant currently known as *Daubenya angustifolia* is either *Massonia marginata* Willd. ex Kunth or *Massonia rugulosa* Licht. ex Kunth. Again, both species were described in the same publication. Enquiries suggest that the Lichtenstein material is no longer extant (R. Vogt pers. comm.) but the Willdenow collection is a fine specimen that coincides with the current concept of the taxon and is therefore chosen here to represent the species.

The confusion between *M. angustifolia* and the taxon now correctly known as *D. marginata* can probably be traced to Baker's treatment in *Flora capensis* (Baker 1896). An earlier coloured engraving of the species (Ker Gawler 1804), based on Masson's original collections, shows all of the characteristics evident in the engraving in *Hortus kewensis*, thereby reaffirming the Linnean concept of the species. Likewise, Baker's interpretation of *M. angustifolia* as having white, fragrant flowers with reflexed tepals also coincides perfectly with the original concept of the species. However, the second of the two specimens cited by him (*Zeyher s.n.*, K, drawing BOL!; the other is the typical Thunberg material) represents the plant described as *Massonia zeyheri* Kunth, which was considered by some authors (Jessop 1976) to be conspecific with *D. marginata*. Both Jessop (1976) and Müller-Doblies & Müller-Doblies (1997) were apparently misled by the fictitiously long tube in the original engraving and by the misattributed *Zeyher* collection, into equating the species with *M. marginata* and *M. zeyheri* respectively.

Daubenya marginata *(Willd. ex Kunth) J.C.Manning & A.M.van der Merwe*, comb. nov.

Massonia marginata Willd. ex Kunth, Enumeratio plantarum 4: 299 (1843). *Polyxena marginata* (Willd. ex Kunth) Benth. & Hook.f. ex T.Durand & Schinz: 366 (1893). *Neobakeria marginata* (Willd. ex Kunth.) Schltr.: 150 (1924). Type: South Africa, Caput Bona Spei (*B-WILLD6373*, holo.–NBG, photo.!).

Massonia rugulosa Licht. ex Kunth: 299 (1843). *Polyxena rugulosa* (Lichtenst. ex Kunth) Baker: 420 (1896). *Neobakeria rugulosa* (Licht. ex Kunth) Schltr.: 150 (1924). Type: Caput Bona Spei, *Lichtenstein 224* (B, holo., ?destroyed).

Polyxena haemanthoides Baker: t. 1727 (1888). *Neobakeria haemanthoides* (Baker) Schltr.: 150 (1924). Type: South Africa, Nuweveld Mountains near Fraserburg, *Bolus 5493* (BOL!, lecto., here designated, G, SAM).

Massonia angustifolia auct. non *M. angustifolia* L.f. (= M. echinata *L.f.*)

Massonia echinata *L.f.*: 193 (1782). Type: South Africa, Crescit juxta margines montis, dicate Bocklands Berg [= Bokkeveld Mountains], *Thunberg s.n.* (*UPS-7992*, holo.!).

Massonia angustifolia L.f.: 193 (1782). *M. lanceolata* Thunb.: 40 (1794) nom. superfl. *Polyxena angustifolia* (L.f.) Baker: 419 (1896). *Neobakeria angustifolia* (L.f.) Schltr.: 150 (1924). *Daubenya angustifolia* (L.f.) A.M.van der Merwe & J.C.Manning in Goldblatt & Manning: 713 (2000). Type: South Africa, Crescit in summo monte Onderste Roggeveldt, 16.11.1774 (*UPS-THUNB7990* excl. fruiting fragments, holo.!), syn. nov.

ACKNOWLEDGEMENTS

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THYMELAEACEAE

SYSTEMATICS OF *PASSERINA TRUNCATA* AND A NEW SUBSPECIES *MONTICOLA*

INTRODUCTION

Most of the *Passerina* L. species are endemic to the Cape Floristic Region. The rejection of the name *Lachnaea conglomerata* L. (Rhamnaceae) (Cafferty & Beyers 1999; Brummitt 2000) has necessitated nomenclatural changes to *P. glomerata* Thunb., a taxon also recognized in the now outdated revision of Thoday

(1924). In the present paper the name *P. glomerata* is rejected and *Passerina rigida* Wikstr. var. *truncata* Meisn. is raised to the species level. Based on leaf anatomy (Bredenkamp & Van Wyk 1999, 2000, 2001a) as well as vegetative and floral morphology (Bredenkamp & Van Wyk 2001b), a new subspecies of *P. truncata* is described.

MATERIALS AND METHODS

Material from the following herbaria was studied: B, BM, BOL, BREM, C, G, GRA, HAL, K, LINN, M, MEL, MO, NBG, NCY, P, PR, PRC, PRE, S, SAM, SBT, SRGH, TCD, UPS, W and WU. For the anatomical study, both fresh and rehydrated leaves were used. For *Passerina truncata* subsp. *truncata*, vouchers of *Bredenkamp 973*, *977*, *984*, *985*, *988*, *994*, and *1002* were used; for *P. truncata* subsp. *monticola*, *Stokoe 8040* and *Esterhuysen 28587* were used.

Light microscope (LM) was used in general leaf anatomical studies. Methods used to prepare transverse sections and cuticle preparations are described by Bredenkamp & Van Wyk (2000).

Scanning electron microscope (SEM) was used to study the leaf surface (including epicuticular waxes) and to verify the structure of the cuticular membrane (Bredenkamp & Van Wyk 2000).

Transmission electron microscope (TEM) was used to study the structure of the mucilaginous epidermal cell walls (Bredenkamp & Van Wyk 1999).

1. **Passerina truncata** (*Meisn.*) *Bredenkamp & A.E.van Wyk*, stat. nov. Type: Western Cape, near Tulbagh Waterfall, April 1865, *Zeyher 43* (K!, lecto., here designated; MEL!, MO!, NBG!, S!, W!).

Passerina rigida Wikstr. var. *truncata* Meisn. in A.D.C., Prodromus systematis naturalis 14 ,: 563 (1857); C.H.Wright: 13 (1915); Thoday: 153 (1924).

Passerina rigida Wikstr. var. *tetragona* Meisn.: 563 (1857) pro parte quoad specimen *Drège 2971*; C.H.Wright: 13 (1915); Thoday: 153 (1924). Type: Western Cape, circa Ezelsbank *Drège 2971* (P!, lecto., here designated; K!).

Lachnaea conglomerata L.: 560 (1753); L.: 374 (1784); Willd.: 434 (1799); Wikstr.: 323 (1818); Thunb.: 374 (1825); Meisn.: 562 (1857); Cafferty & Beyers: 171, 172 (1999); Brummitt: 805 (2000) nomen rejiciendum. *Passerina conglomerata* Thunb. fide Wikstr.: 322 (1818) nom. illeg.

Passerina glomerata sphalm. quoad *L. conglomerata* L. sensu Thunb.: 75 (1794); Willd.: 434 (1799); Wikstr.: 323 (1818); Thunb: 374 (1825); Meisn.: 562 (1857); Cafferty & Beyers: 171, 172 (1999). *Lachnaea glomerata* sphalm. quoad *L. conglomerata* L. sensu Thunb.: 75 (1794). *Passerina ericoides* sensu Thunb.: 374 (1825) non L.: 236 (1767, 1771). *Passerina glomerata* sensu Thoday: 153 (1924) nom. illeg.

Shrubs, shrublets or low stunted shrublets (0.2–)0.4–1.5(–2.0) m high. *Stems* branching from base to growing points; branchlets ascending, straight or arcuate (subsp. *monticola*), greyish brown, younger branchlets whitish tomentose, older branchlets with whitish scales, remains of indumentum and scales flaking off with cork on older branchlets; cork fissured between leaf scars or tesselate, scaberulent. *Leaves* sessile, decussate, imbricate on young branchlets, diverging at 15°–45°, four-ranked, cymbiform; lamina inversely ericoid, narrowly oblong to oblong in outline, length × depth (1.7–)2.0–3.0(–4.0) × (0.6–)0.8–1.0 (–1.7) mm, becoming keeled in upper part; adaxial surface concave, tomentose; abaxial surface laterally compressed and glabrous; apex truncate or rounded (subsp. *monticola*); base dilated; margins involute. *Inflorescences* comprising polytelic synflorescences, spikes reduced, resembling terminal subcapitulate inflorescences, each characterized by two terminal leaves with axillary blind-ending rudimentary flowers, enveloping minute growing point; proliferating growth less common; subcapitulate inflorescences ± ellipsoid, pale green or straw-coloured, 4–8-flowered. *Bracts* enveloping flowers and fruits, accrescent after anthesis, becoming more coriaceous and rounded at fruit set, decussate, imbricate, sessile, appressed or ascending, obovate to widely obovate in outline, length × depth (2.5–)2.9–4.0 × 1.4(–2.4) mm, adaxially concave, villous, abaxially convex, glabrous, coriaceous to thickly coriaceous, ribbed (subsp. *monticola*) or ribbed and reticulately veined on both sides of main vein, concolorous, pale green or greyish green, senescing to yellowish brown; base cuneate; main vein extending into obtuse to acute apex; margins involute. *Flowers* actinomorphic, bisexual, hypogynous. *Floral envelope* 4.9–6.4 mm long, comprising a hypanthium (fused calyx and androecium) and calyx lobes, papyraceous and yellow-pink during pollination, dehydrated after shedding of pollen, turning red to brown. *Pedicel* very short or absent. *Receptacle* very short. *Disc* absent. *Hypanthium* a membranous cylindric tube, glabrous at ovary or apex of ovary tomentose, neck tomentose, 0.7–0.8 mm long, abscission tissue and articulation plane absent. *Calyx* petaloid; lobes 4, imbricate in bud, flexed in flower; outer lobes concave ovate or cymbiform, adaxially sparsely pubescent or apex tomentose, abaxially glabrous; inner lobes oblong to elliptic or widely obovate, adaxially sparsely pubescent or tomentose, abaxially glabrous. *Corolla* absent. *Petaloid scales* absent. *Androecium* dimorphic, diplostemonous, arising from hypanthium at separation point of calyx lobes; filaments of antipetalous whorl 0.9–1.2 mm and those of antisepalous whorl ± 1.4 mm long; anthers (0.8–)0.9 × 0.4 mm, sub-basifixed, 2-thecous and 4-locular. *Ovary* superior (2.4–)2.5 × 0.9 mm, unilocular, placentation parietal; ovule 1, pendulous, laterally attached near top of ovary. *Style* situated laterally from top of ovary, maintaining lateral position in hypanthium neck, reaching beyond hypanthium rim. *Stigma* ± globose, moplike or penicillate. *Fruit* an achene with pericarp membranous and dry, 2.5 × 1.2 mm, enveloped by persistent, loosely arranged hypanthium, the latter fragmenting over widest circumference of fruit, resulting in shedding of fragmented hypanthium, calyx lobes and androecium. *Seed* broadly fusiform with outgrowths at both micropylar and funicular ends; tegmen black and shiny, often with white spots; endosperm formation nuclear, but later becoming cellular throughout. *Conservation status*: Not Threatened (IUCN Species Survival Commission 1994).

Key to subspecies

1a Shrubs or shrublets from various habitats; stems branching from base, straight; branchlets straight; leaves diverging at ± 15°, narrowly oblong to oblong, apex truncate, keeled, appearing humped on the back; bracts appressed,

thickly coriaceous, ribbed and reticulately veined on each side of main vein, greyish green, senescing to yellowish brown; main vascular bundle variously arranged, types B2, 3, 5 (Bredenkamp & Van Wyk 2001a) . . . . 1a. subsp. *truncata*

1b Shrubs or low shrublets from mountain habitats; stems often stunted; branchlets lax, arcuate; leaves diverging at ± 45°, narrowly oblong, apex truncate to rounded and keeled; bracts ascending, coriaceous, ribbed on each side of main vein, pale green; main vascular bundle bordering on abaxial epidermis, type B6 . . 1b. subsp. *monticola*

Leaf anatomy

Leaf inverse-dorsiventral, epistomatic. *Outline* in transverse section (t/s) transversely elliptic. *Lamina* width (570–)740–830(–980) µm, midrib in t/s (290–) 330–460(–500) µm. *Adaxial epidermis* uniseriate, stomata anomocytic, cuticular membrane (CM) ± 2 µm thick; periclinal cell diam. 15 µm, anticlinal cell diam. 12.5 µm. *Abaxial epidermis* in surface view, cells arranged randomly, isodiametric or slightly oblong, pentagonal to heptagonal, (30–)40–55 × 30–40 µm; CM smooth or with several domes per cell, wax platelets scarce, square to oblong, raised 30°–90°, rounded to sharp edges; CM in t/s (20–)30–40(–50) µm thick, periclinal cell diam. (20–)30–45 µm, anticlinal cell diam. (25–)30–60 µm, epidermal cells large, with thick inner periclinal cell walls, becoming mucilaginous and containing abundant amounts of tanniniferous compounds; outer periclinal wall domed. *Mesophyll*: palisade parenchyma in 2 or 3 layers of elongated cells with abundant chloroplasts and tanniniferous compounds, density 3–5 cells per 50 µm; spongy parenchyma of irregular cells ± densely arranged with largest intercellular spaces close to vascular bundles. *Main vascular bundle* centrally arranged (type B2) (Bredenkamp & Van Wyk 2001a), touching palisade parenchyma abaxially (type B3), or with palisade parenchyma abaxial of main vascular bundle specializing into collenchyma, containing ample amounts of tanniniferous substances (type B5), or bordering on abaxial epidermis (type B6) (subsp. *monticola*), ovate with ample sclerenchyma, or widely to very widely ovate with sclerenchyma bulging laterally. *Bundle sheath* of (21–)25–30(–32) parenchymatous cells, ± rounded, tanniniferous substances strongly present adaxially or specializing into collenchyma abaxially. *Secondary growth* present (subsp. *truncata*). *Secondary vascular bundles* 2–4 on each side of main bundle. *Sclerenchymatous hypodermal sheath* absent. Figure 4.

Nomenclatural notes

Lachnaea conglomerata was described by Linnaeus (1753), with synonyms from Plukenet (1700), Ray (1704) and Breyne (1678). This name was subsequently also used by Linnaeus in *Systema vegetabilium* (1784). However, there is no material of this taxon in the Linnean Herbarium (Savage 1945). The only original element found, is the illustration by Breyne (1678), determined as *Phylica stipularis* L. by Cafferty & Beyers (1999).

Thunberg (1794), in error, made the illegitimate combination *Passerina glomerata*, citing '*L. glomerata* Linn. Syst. 374' in synonymy. The specimen *Herb. Thunberg 9577* (UPS) (Figure 5), bears the inscription '*Passerina glomerata* α (Lin. herb.)' and was determined by Thoday as the type of *P. glomerata* Thunb. However, specimens *504.2* & *504.3* referred to in the Linnean Herbarium (Savage 1945), are both *P. paleacea* Wikstr., suggesting that Thunberg did not have a clear interpretation of *P. glomerata*. The specimen *Herb. Swartzii s.n.* (S) bears the name *Lachnaea conglomerata* L. and has been correctly identified as *P. glomerata fide* Thunberg (1794) and Thoday (1924). Unfortunately, neither Thunberg nor any of the contemporary Swedish botanists were aware that the illustrated synonym in Breyne on which *Lachnaea conglomerata sensu* Linnaeus was based, represents *Phylica stipularis* L. (Rhamnaceae). Thunberg clearly intended to base his new name on the Linnean concept, referring to 'Linn Syst. 374' and 'Lin. herb.'.

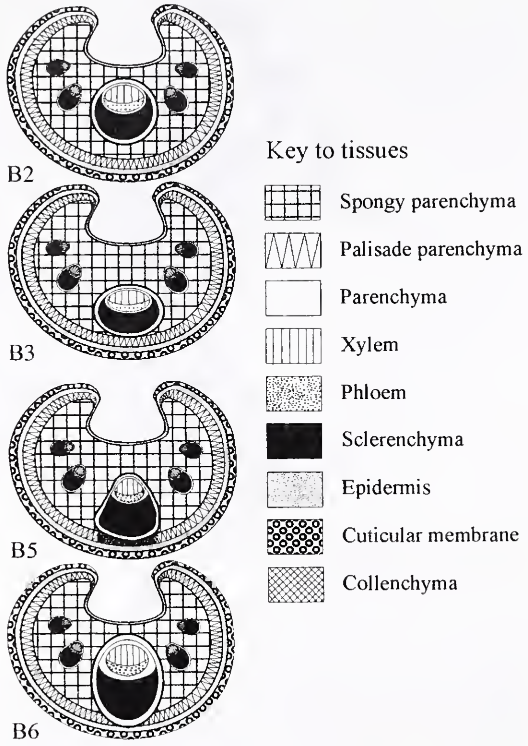

FIGURE 4.—Diagrammatic representation of t/s of leaves. *P. truncata* subsp. *truncata* characterized by leaf structural types B2, 3 & 5, and subsp. *monticola* by type B6.

Willdenow (1799) once again reinstated *L. conglomerata*, sinking *P. glomerata* Thunb. Wikström (1818) retained *P. conglomerata*, citing both *P. glomerata* and *L. conglomerata* in synonymy. Wikström's concept is clearly illustrated by two specimens from the Bergius Herbarium (SBT) bearing the inscriptions *Lachnaea conglomerata* Linn. and *Passerina conglomerata* Thunb. Adding to the confusion about the concept of the taxon, he referred to 'Hautbay', today Hout Bay, as the locality for the species, which is the known habitat of both *P. paleacea* and *P. ericoides* L. Thunberg (1825) accepted Wikström's concept of *P. glomerata*, citing *P. ericoides* in synonymy. This confusion is reflected by many

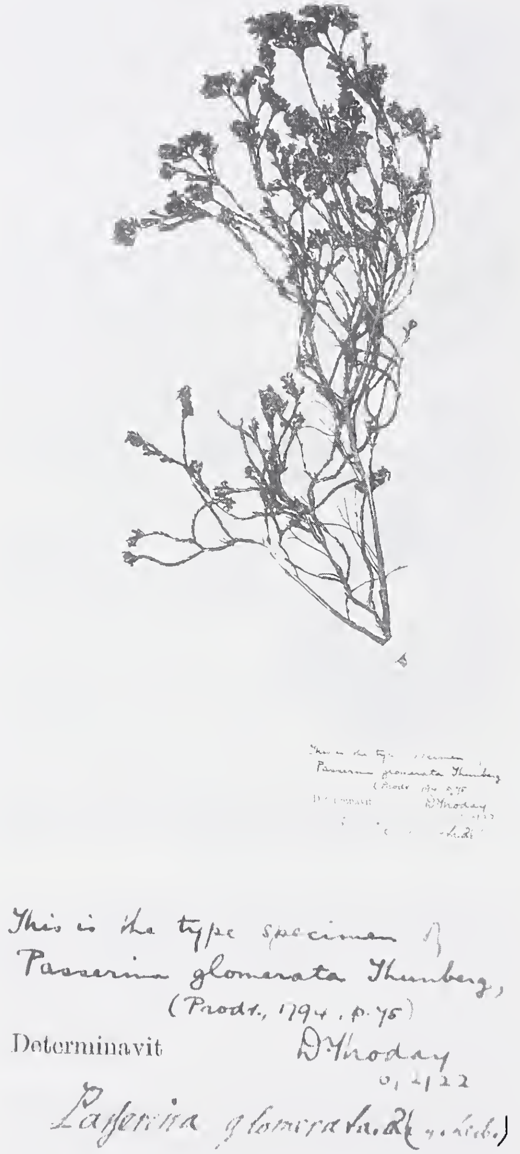

FIGURE 5.—The specimen *Herb. Thunberg 9577* (UPS), bearing inscription 'Passerina glomerata α (Lin. herb.)' and determined by Thoday as the type of *P. glomerata* Thunb.

herbarium specimens, e.g. *Thunberg s.n.* (S), presently identified as *P. glomerata* Thunb., misidentified as *P. ericoides* (= *Lachnaea conglomerata*); the specimen *Herb. Thunberg 9596D* (UPS), identified as *P. paleacea* by Thoday in 1922, with inscriptions '*P. ericoides* Linn.' and '*L. conglomerata* (Linn.)'. Recognizing the continuous confusion, Meisner (1857) cited both *P. glomerata* and *L. conglomerata* in synonymy under *P. ericoides*.

In the interest of nomenclatural stability, the proposal by Cafferty & Beyers (1999) to reject the name *Lachnaea conglomerata* L. was recommended by the Committee for Spermatophyta (Brummitt 2000). Article 56.1 of the International Code of Botanical Nomenclature (Greuter *et al.* 2000) states that combinations based on *nomina rejicienda* should be similarly rejected. As Thunberg clearly indicated that his concept of *P. glomerata* was based on the Linnean concept of *L. conglomerata*, the name *P. glomerata* is also rejected.

Meisner (1857) placed both *P. glomerata* and *L. conglomerata* in synonymy under *P. ericoides*. Furthermore, he described two new varieties under *P. rigida*, namely var. *tetragona* and var. *truncata*. Both these varieties included authentic material later cited by Thoday (1924) in his description of *P. glomerata*. Based on the specimen *Herb. Thunberg 9577* (UPS) (Figure 5) as the type, Thoday (1924) reinstated *P. glomerata* Thunb. and placed Meisner's two varieties in synonymy, unaware of the fact that Thunberg (1794) had made the illegitimate combination *P. glomerata*, in error. The rejection of *L. conglomerata* (Cafferty & Beyers 1999; Brummitt 2000) and *P. glomerata*, implied the choice of a new name for the existing species. As all the specimens included in *P. rigida* var. *truncata* are delineated by '*foliis ramulo adpressis vel semipatulatis truncatis*' and their distributions coincide perfectly with the distribution of the previously known *P. glomerata sensu* Thoday, the var. *truncata* was consequently selected and is here raised to the species level. The var. *tetragona* included *Drège 2971* (K, P) from Ezelsbank in Western Cape, presently placed in synonymy under *P. truncata*, and *Drège s.n.* from Stormberg in the Eastern Cape, presently identified as *P. montana*.

1a. subsp. **truncata**

Diagnostic characters and relationships: the typical subspecies may easily be distinguished by its decussate, imbricate, four-ranked leaves, spreading at an angle of 15°. The leaves are abaxially laterally compressed and glabrous, narrowly oblong to oblong, with a dilated base and a truncate, keeled apex, appearing humped on the back. Inflorescences are reduced spikes, terminally subcapitulate. Bracts are obovate to widely obovate. The lamina is villous on the inside and glabrous on the outside. It is thickly coriaceous, ribbed and reticulately veined on each side of the main vein, which extends into an obtuse apex. Bracts are greyish green in colour, senescing to yellowish brown. *P. truncata* could be confused with *P. quadrifaria* Bredenkamp & A.E.van Wyk ined., which is characterized by shortened leaf-bearing branchlets with closely arranged nodes, very short internodes and leaves spreading at an angle of 45°. The abaxial surface is convex and tomentose in young leaves and the leaf apex is rounded.

Etymology: the specific epithet is from the Latin *truncatus* = ending very abruptly, as if cut straight across. It describes the truncate apex of the leaves.

Distribution and habitat: subspecies *truncata* is confined mainly to the Fynbos (Rebelo 1998) and Succulent Karoo Biomes (Hoffman 1998) of the Northern and Western Cape. It occurs in the Northwestern, Southwestern, Karoo Mountain and Southeastern centres of endemism (Goldblatt & Manning 2000) within the Cape Floral Region. In the Northern Cape, it is distributed from Steinkopf, through Namaqualand, Nieuwoudtville and

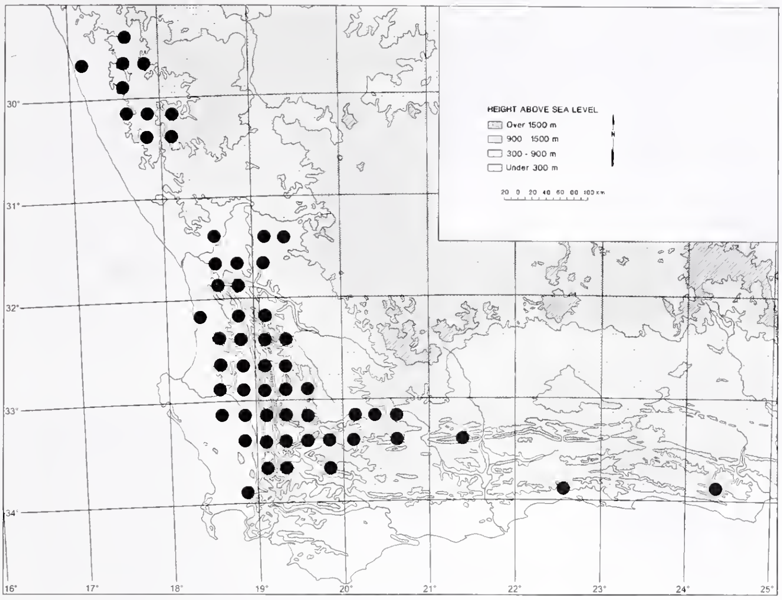

FIGURE 6.—Known distribution of *P. truncata* subsp. *truncata*.

Vanrhynsdorp to Wolfberg. This subspecies is common in the Western Cape, where it is distributed from Vanrhynsdorp, the Koue Bokkeveld, Clanwilliam, the Olifants River Valley, Citrusdal, along the Cederberg Mountains, to Malmesbury, Ceres, Tulbagh, Matjiesfontein and Seven Weeks Poort. The most southeasterly known locality is Baviaanskloof near Patensie (*Bayliss 546*). Subsp. *truncata* is adapted to a wide range of habitats. It occurs on low-lying plains as well as on several mountain ranges, where it is common on level ground, rocky slopes and along watercourses. Subsp. *truncata* is one of the most dominant taxa between Tulbagh and Clanwilliam, where the size of the shrubs varies from 0.4–1.5(–2.0) m on flat areas and plains. They grow prolifically, and during flowering time yellow, yellowish pink and red flowers can often be seen on the same plant, representing various stages of maturation. This subspecies is also common in the arid Karoo environment of the Witteberg Mountains near Matjiesfontein, where it grows in rocky areas. In extremely dry areas of Namaqualand, the Ceres-Karoo and on top of the Skurweberg and Cederberg Mountains, the growth form of the subsp. *truncata* changes to a hardy, skeletal, less-branched, sclerophyllous shrublet, with yellow, coriaceous leaves, closely arranged on the stem, but with each growing point protected by a pair of conspicuous, coriaceous bracts. Figure 6.

1b. subsp. **monticola** *Bredenkamp & A.E.van Wyk*, subsp. nov., a subspecie typica praecipue habitu differt. *Frutices* vel fruticuli in habitu montano in fissuris rupium radicantes. Ramuli adscendentes, laxi, arcuati. *Folia* ad angulum 45° divergentia, anguste oblonga, carinata, apice truncato vel rotundato. *Bracteae* adscendentes, obovatae ad late obovatae, coriaceae, utrinque costae costatae, pallide virides.

TYPUS.—Western Cape, 3319 (Worcester): Robertson Division, Omklaar, (–DD), 1923, *Stokoe 22330* (PRE!, holo.; K!, iso.).

Shrubs or low stunted shrublets 0.2–1.5 m high, often rooted in rock crevices. *Stems* often stunted, branching profusely on younger growth, branchlets ascending, arcuate; younger branchlets densely whitish tomentose; cork fissured between yellowish leaf scars. *Leaves* diverging at ± 45°, narrowly oblong in outline, length × depth (2.4–)2.6(–3.0) × 0.6–1.7 mm; abaxial surface laterally compressed and glabrous; apex truncate to rounded; base dilated. *Inflorescences* subcapitulate, ± ellipsoid, pale green. *Bracts* ascending, obovate to widely obovate; lamina adaxially concave, villous, abaxially convex, glabrous, coriaceous, ribbed, pale green, base cuneate; main vein extending into obtuse to acute apex; length × depth (2.5–)2.9 × 1.5 mm. *Flowers*: floral envelope ± 4.9 mm long. *Hypanthium*: apex of ovary tomentose, neck tomentose, ± 0.7 mm long. *Calyx*: outer lobes concave ovate, apex adaxially tomentose, abaxially glabrous; inner lobes widely obovate, adaxially tomentose, abaxially glabrous. *Androecium*: filaments of antipetalous whorl ± 1.2 mm and antisepalous whorl ± 1.4 mm long; anthers 0.9 × 0.4 mm. *Ovary* 2.5 × 0.9 mm. *Conservation status*: Not Threatened (IUCN Species Survival Commission 1994). Figure 7.

Diagnostic characters and relationships: *Passerina truncata* subsp. *monticola* can easily be distinguished from the typical subspecies by its growth form. The plants are often low shrublets rooted in rock crevices on mountain peaks. The stems are stunted, branching profusely on younger growth, the branchlets are ascending, lax and arcuate. The leaves spread at 45°, are narrowly oblong and the apex is truncate to rounded and keeled. The bracts retain the characteristic shape of subsp. *truncata*, but are ascending, smaller and pale green. The characteristic lax, arcuate branchlets of this subspecies also distinguish it from *P. quadrifaria*.

Etymology: the subspecific epithet *monticola* = mountaineer, referring to the mountainous habitat of the subspecies.

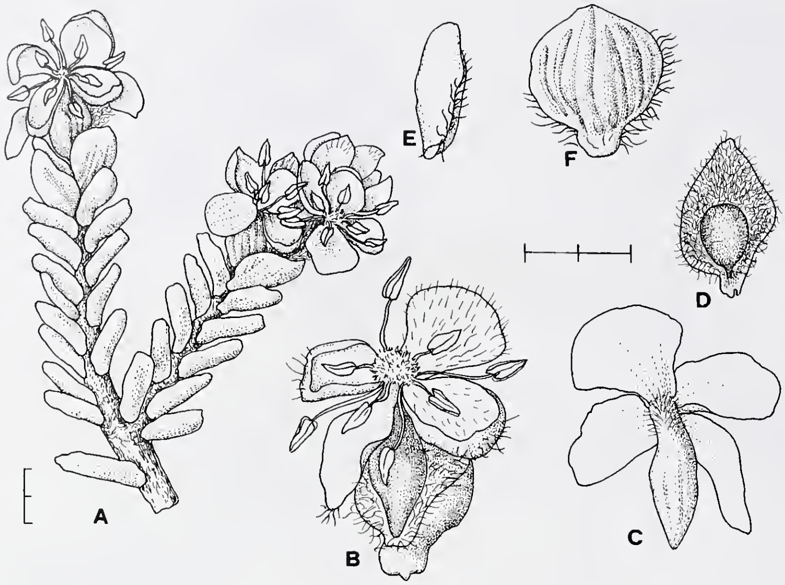

FIGURE 7.—*P. truncata* subsp. *monticola, Esterhuysen 28587.* A, flowering branch; B, flower clasped by bract; C, indumentum of hypanthium tube and glabrous abaxial surfaces of calyx lobes; D, fruit in tomentum of bract; E, leaf; F, bract. Scale bars: 2 mm.

Distribution and ecology: subspecies *monticola* is distributed south of 32°S latitude and between 18°E and 20° longitude. It occurs in the Northwestern, Southwestern, and Agulhas Plain centres of endemism (Goldblatt & Manning 2000) of the Cape Floristic Region. It grows in mountainous areas and is distributed from Clanwilliam, along the Cederberg Mountains, southwards along mountain ranges and summits to Table Mountain, Helderberg, Kogelberg, the Hex River Mountains and the Riviersonderend Mountains.

Plants are often found in rock crevices or in damp sheltered gullies. They also occur on western, southwestern and eastern slopes and on shale bands at an altitude of 1 667–2 000 m, on Sneeukop (Goudini). The most common habitat is on mountain summits, e.g. Sneeuberg, Slanghoek Pile, Zebra Kop, Jonaskop and Buffelshoek, as well as on mountain peaks, e.g. Milner, Du Toits, Uitkyk and Bailey's Peaks, at altitudes of ± 2 000 m. Figure 8.

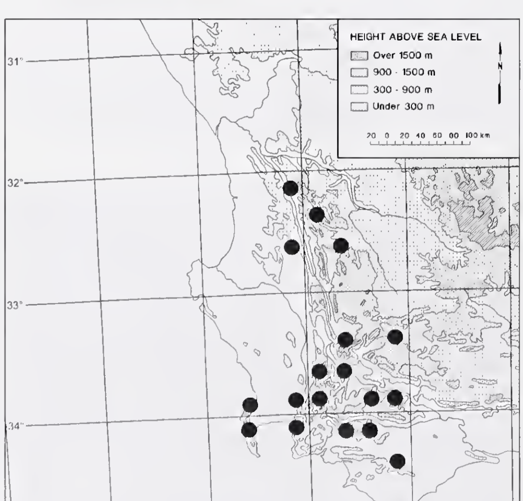

FIGURE 8.—Known distribution of *P. truncata* subsp. *monticola*.

ACKNOWLEDGEMENTS

The authors would like to thank Ms Gill Condy for the line drawings, Dr O.A. Leistner for translating the diagnosis into Latin and Ms A. Romanowski for printing the photograph.

SPECIMENS EXAMINED

Acocks 1002, 1004, 3045, 3214 (1a) S; *17234* (1a) K, PRE; *19397* (1a) K, M, PRE; *23678* (1a) PRE. *Almborn 475* (1a) MO; *539* (1a) M. *F. Archer 120* (1a) NBG, PRE.

Barker 5751, 9217, 10286 (1a) NBG. *Bayliss 577* (1a) M, MO, PRE; *591, 1105, BRI-B591* (1a) K, MO, PRE; *BRI-B546* (1a) PRE. *Bellamy 2* (1a) PRE. *Bolus 9507* (1a) BOL, K. *Boucher 1983* (1a) NBG; *2872* (1a) K, NBG, PRE; *2880* (1a) PRE; *3177* (1a) C, K, NBG, PRE. *Bredenkamp 972, 973, 977, 978, 983, 985, 986, 988–994, 1004–1011* (1a) PRE. *Bremer 264* (1a) PRE, S. *Buchell 387* (1a) PRE.

Compton 519 (1a) NBG, S; *1404* (1b) NBG; *2800* (1a) BOL, NBG; *3327* (1a) BOL, K; *3743* (1a) NBG; *4894* (1a) BOL; *4901, 5890* (1a) BOL, NBG; *6347* (1b) NBG; *6546, 6902, 9537* (1a) NBG; *9970* (1a) MO, NBG; *11701, 11718, 12237, 15020, 18781* (1a) NBG; *19949* (1a) NBG, MO; *22821* (1a) S; *24331* (1a) NBG, MO.

Dahlgren & Peterson 257 (1a) K. *Davis s.n.* (1a) NBG, PRE, SAM. *Drège 2971* (1a) K, P; *s.n.* (1a) K.

Ecklon & Zeyher s.n. (1a) BREM, MO, S. *Emdon 197* (1a) C, K, PRE. *Esterhuysen 1327* (1a) BOL; *1744* (1b) BOL; *2273* (1a) BOL; *3638* (1b) BOL; *3703* (1a) K; *7380, 8416, 9542, 9822, 9921* (1b) BOL; *10886* (1a) BOL; *11046* (1b) BOL; *11255* (1b) BOL, K; *26859* (1a) K; *27451* (1b) BOL; *28555* (1b) BOL, K; *28574, 28587, 30573, 30910* (1b) BOL; *32195* (1a) MO. *Evrard 9001* (1a) MO, PRE, UPS.

Forrester 114, s.n. (1a) NBG.

Galpin 11209, 11210, 11218 (1a) BM, C, PRE, UPS. *Gillett 397* (1a) NBG; *4012* (1a) BOL, K, PRE. *Alice Godman 527* (1a) BM. *Goldblatt 2757* (1a) M, NBG, PRE, S; *2802* (1a) C, PRE, M, MO; *7264* (1a) MO, PRE, S. *Greuter 21765* (1a) PRE. *Guthrie s.n.* (1b) NBG.

Hanekom 943 (1a) NBG, PRE; *1249* (1a) K, PRE. *Hardey 448, 449* (1a) PRE, BM, K, M. *Herb Swartzii s.n.* (1a) S. *Herb Thunberg s.n.* (1a) UPS. *Hiendlmayr s.n.* (1a) M. *Howes 225* (1a) K, PRE. *Hugo 545, 679* (1a) K, PRE. *Hugo & Manve 4* (1a) K, MO, NBG, PRE. *Hutchinson 416* (1a) BM, GRA, K, PRE; *834* (1a) GRA, K, PRE.

Johnson 519 (1a) NBG. *Jordaan 545* (1a) NBG.

Kerfoot K5061 (1b) NBG. *Kotze 45* (1a) NBG. *Kruger 911* (1a) NBG, PRE; *1754* (1b) PRE.

Le Roux 2310 (1a) PRE. *Levyns 1232, 1335, 1370, 1377, 1808, 1941, 2165, 2382, 2415a, 4108* (1a) BOL. *Lewis 2730, 4061, 4062* (1a) NBG; *62671* (1a) MO; *SAM67057, SAM67058* (1a) NBG, PRE; *Lewis s.n.* (1a) NBG. *Linscherg s.n.* (1a) S. *Loubser 598* (1a) NBG.

Maguire 2025 (1a) C, NBG. *Marloth 4238* (1a) K, PRE; *6626* (1b) NBG, PRE; *6873, 6957* (1a) PRE; *10668* (1a) NBG; *10798, 11426, 11686, 12943* (1a) PRE; *13006, 13007* (1a) NBG, PRE; *13144* (1a) PRE. *Merxmuller & Giess 3832* (1a) M, PRE. *Metelerkamp 562, 562a* (1a) BOL. *Meyer 74* (1a) NBG. *Morley 250* (1a) NBG, PRE. *Museum Botanicum Hauniense* (1a) C.

Nortje 17 (1a) NBG.

Pappe s.n. (1a) K. *Pearson 5709, 6256* (1a) BOL, K; *6765* (1a) K; *6773* (1a) BOL; *6782* (1a) K. *Pearson & Pillans 5928* (1a) K. *Phillips 2057* (1a) NBG. *Pillans 7298* (1a) K; *7298, 7769* (1b) BOL; *8021* (1a) BOL; *9606, 10705* (1a) MO; *63799* (1a) BOL, MO, PRE. *Pocock 770* (1a) NBG, PRE.

Rauh 3553 (1a) M. *Rourke 961* (1b) MO, NBG.

Salter 1568 (1a) K. *Schlechter 10627* (1a) BM, K, MO, PRE, S; *10660* (1a) BM, K, PR, PRE, S. *Solomon 92* (1a) NBG. *Stehle 309* (1b) NBG. *Stephens 7226, 7264* (1a) K. *Stirton 10148* (1a) PRE. *Stokoe 1460* (1a) PRE; *2520* (1b) PRE; *8040* (1b) BOL; *8041* (1a) BOL; *8042* (1a) BOL, GRA, NBG, PRE; *8225* (1b) BOL; *17574* (1b) BOL, PRE; *22330* (1b) K, PRE; *22331* (1a) BOL, PRE; *64616* (1b) PRE; *s.n.* (1a) NBG; *s.n.* (1b) BOL, NBG. *Stokoe & Davis s.n.* (1a) NBG. *Story 4303* (1a) K, GRA, PRE. *Strid 37832* (1a) C, NBG.

Taylor 2865 (1a) NBG, S; *3921* (1a) PRE; *4011* (1a) NBG; *6145* (1b) PRE; *6495* (1a) NBG, PRE; *8664* (1a) K, NBG, PRE, S; *9293* (1a) PRE; *10483, 10618* (1a) NBG, PRE. *Thoday 213* (1a) NBG; *1921* (1a) BOL. *Thompson 1278, 1519* (1a) NBG; *2823* (1a) K, MO, NBG, PRE. *Thunberg s.n.* (1a) S, SBT. *Tyson 318* (1a) NBG; *1452* (1a) PRE; *2318* (1a) K.

Van Breda 198 (1a) PRE. *Van Rooyen 2401, 2626* (1a) M. *Van Rooyen, Steyn & De Villiers 618* (1a) NBG. *Van Son TRV36623* (1a) PRE. *Van Wyk 6485* (1a) PRE. *Van Zyl 3295* (1a) K, MO, PRE.

Wagener 259 (1a) NBG. *Whitehead s.n.* (1a) TCD.

Zeyher 43 (1a) K, NBG, MO, S; *s.n.* (1a) M. *Zietsman & Zietsman 925, 1151* (1a) PRE.

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APOCYNACEAE

A NEW SPECIES OF *BRACHYSTELMA* FROM EASTERN CAPE, SOUTH AFRICA

Brachystelma cummingii *A.P.Dold*, sp. nov., *B. tenellum* R.A.Dyer affinis base inflata gemmae pentagona (non globosa): lobis interioribus coronae rectangulatis (non anguste linearibus); lobis interioribus coronae non appendiculatis-dentatis; corpusculo clavato (non rectanulato): pagina interiori loborum trichomis sparsis acuticylindricis, albis adprementibusque, in longitudinem ordinatis (non pilis longis albisque).

TYPE.—Eastern Cape, 3324 (Steytlerville): Kleinpoort, (–BD), 550 m, 27-01-2001, *Dold 4368* (GRA, holo.).

Perennial herb with tuber. *Tuber* depressed, spherical, not exposed, 20–25 mm high, ± 30 mm diam. *Stems* 1–3 from single central growth point, erect, occasionally branching above ground level, below 10 mm, 0.5–1.0 mm

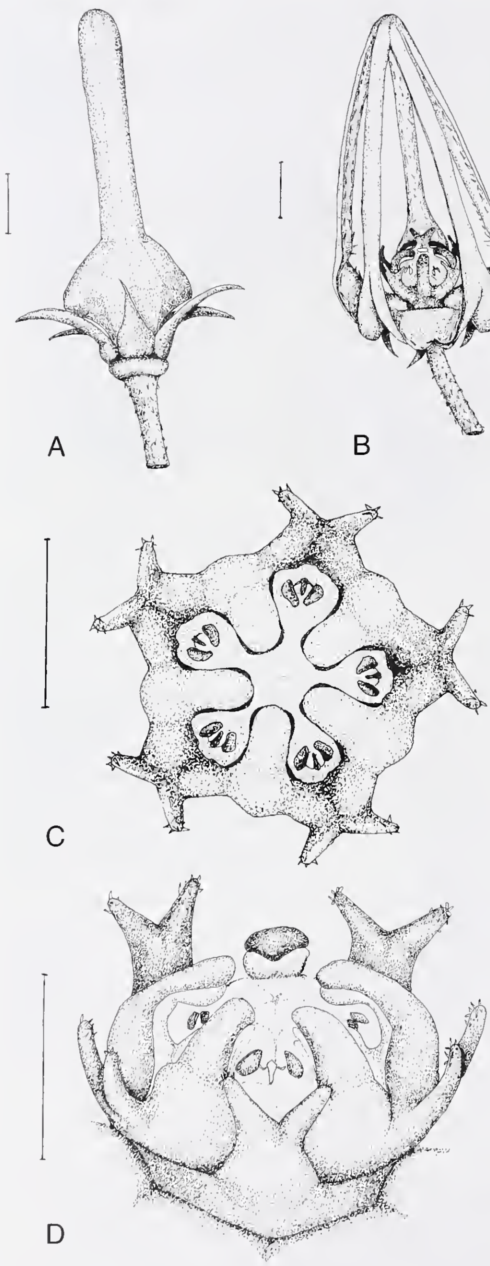

FIGURE 9.—*Brachystelma cummingii, Dold 4368*. A, flower bud; B, flower at anthesis; C, D, corona, view from top and side. Scale bars: 1 mm. Illustrations: A. Dold.

thick at base, 0.4–0.5 mm thick above, 100–150 mm long, internodes 4 mm at base to 10–14 mm above, dull purple at base, new growth green, white puberulous. *Leaves* sessile, basal 3 or 4 pairs elliptic, 14–20 × 3–5 mm, erect, often twisted on central axis, margins tinged reddish, upper 10–15 pairs linear, spreading, simple, (10–) 18–20(–22) × 1.0–1.5 mm, entire, V–shaped in cross section, lower keel prominent, upper surface with minute shiny water cells, dark green, lower surface leathery, yellow-green. *Flowers* single, extra-axillary at nodes, opening successively at every node whilst growing, seldom simultaneously; pedicels spreading, 15–18 × 0.4 mm, puberulous, purple. *Bract* persistent, single, extra axillary clasping, lanceolate, acute, ladle-shaped, cuspidate, bluntly spurred at base, 1 × 0.2 mm at base, green becoming dark purple-black. *Sepals* 5, lanceolate, acute, 1.6 × 0.6 mm at base, glabrous, reflexed below corolla sinus, reaching pedicel, persistent, purple. *Corolla*: in bud, inflated base pentagonal, 2 × 2.5 mm, cylindrical beak 4–6 × 0.5 mm, apex rounded; at anthesis, (4.5–) 5.5–6.0(–10) × 3.5–4.0 mm; tube 0.25–0.50 mm, surrounding base of gynostegium, then reflexed up to 1 mm to sinus; lobes deltoid at base, produced into long attenuate lobes connivent at apices, 5–8 mm from apex to sinus, 1.2 mm broad at base, narrowing abruptly to 0.3 mm, sinus between lobes deeply incised, forming an open, pyramidal to ± globose, cage-like structure, inner surface of lobes with sparse, cylindrical-acute, white, adpressed trichomes, each attached to a raised papilla, arranged longitudinally, base dark purple, outer surface paler, upper surfaces dull green to yellow-green. *Gynostegium* 1 mm diam. at base, 1–2 mm high, glabrous, stipe white; outer corona lobes 0.4 × 0.3 mm at base, erect, slightly spreading, flattened, distal end bilobed, lobes spreading laterally forming a shallow V, black, tips sparsely furnished with minute white trichomes; inner corona lobes 5, 0.4 × 0.2 mm at base, flattened, incumbent on and curving inwards distally to cover anthers, black. *Pollinium* semi-ovate, flattened, 0.22 × 0.12 mm, insertion crest along outer edge narrowly, transparently winged, golden brown; corpusculum clavate, 0.15 mm long, orange-brown; caudicle short, broad, orange-brown. *Follicles* paired, linear ± 60 × 3 mm, broadest in the middle, green, minutely and densely mauve-speckled, apices forming minute club-shaped tip. *Flowering time*: November to December. Figures 9–11.

Specimens examined

EASTERN CAPE.—3324 (Steytlerville): De Bordtjie, west of Kleinpoort, (–BC), *Bruyns 6913* (BOL); south of Kleinpoort, (–BD), *Bruyns 4914* (BOL); Kleinpoort, (–BD), *Cumming 7037* (GRA); *Dold 4368* (GRA).

Brachystelma cummingii resembles *B. tenellum* R.A.Dyer (Dyer 1973, 1980, 1983), but differs morpho-

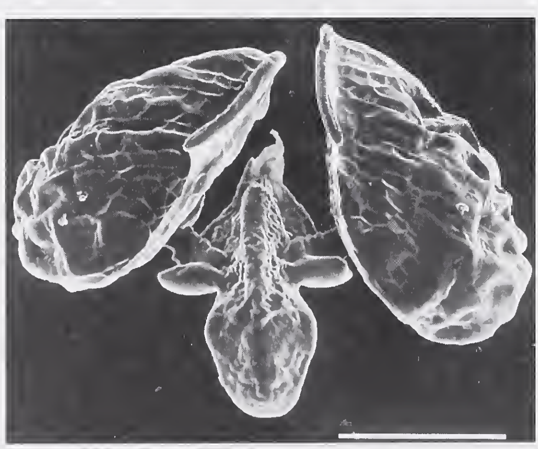

FIGURE 10.—*Brachystelma cummingii, Dold 4368*, pollinarium. Scale bar: 100 µm.

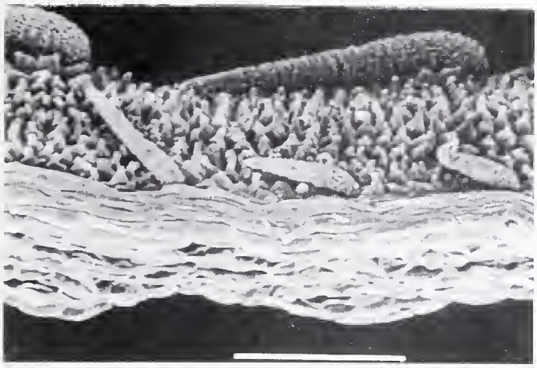

FIGURE 11.—*Brachystelma cummingii*, *Dold 4368*, section of corolla lobe showing adpressed trichomes. Scale bar: 100 μm.

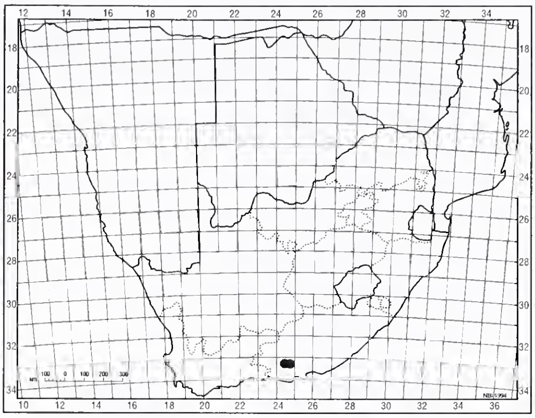

FIGURE 12.—Known distribution of *Brachystelma cummingii*.

logically in several ways (Table 1). The recurved corolla lobe margins of *B. cummingii* resemble those of *B. gracile* E.A.Bruce (Bruce 1949; Dyer 1980, 1983), but are more pronounced, obscuring all but the tips of the calyx. The unusual adpressed trichomes on the inner surface of the corolla lobes of *B. cummingii* are also found on *B. pygmaeum*.

B. cummingii is only known from four specimens, one from De Bordtjie and three from Kleinpoort (Figure 12), at 550–800 m above sea level and is scattered in open rocky grassland on flat surfaces. The vegetation type of both localities is Central Lower Nama-Karoo (Hoffman 1996). Tubers are well below the surface in shallow sandy soil (derived from the Peninsula formation of the Table Mountain geological group) associated with *Aristida adscensionis*, *Dicoma spinosa*, *Digitaria eriantha*, *Eragrostis curvula*, *Euphorbia jansenvillensis* and *Lebeckia pungens*. An average annual rainfall (23 years) of 350 mm has been recorded at Glenconnor, 30 km to the east of Kleinpoort. In the absence of data, it is expected that Kleinpoort and De Bordtjie would have a similar rainfall figure.

TABLE 1.—Morphological differences between *Brachystelma cummingii* and *B. tenellum*

	B. cummingii	*B. tenellum*
Leaf	sessile	petiolate
Pedicel	15–18 mm	10–15 mm
Corolla	4.5–10.0 mm reflexed around tube mouth (1 mm)	3.5–4.0 mm saucer-shaped (0.5 mm)
inner surface	minute, acute, white trichomes	long, white hairs
base of bud	pentagonal	globose
Corona lobes		
inner	rectangular	narrowly linear
outer	shallowly lobed	deeply lobed
Corpusculum	clavate	narrowly rectangular

The locality of *B. cummingii* is significant, as the genus is poorly represented in arid regions (Peckover 1993) compared to areas of higher rainfall. In his revision of the genus, Dyer (1980) recorded only a single species in the Karoo. In comparison, Retief & Herman (1997) record 35 species for the northern provinces of South Africa, whereas Bruyns (2000) records three species of *Brachystelma* for the Cape flora, of which only one is endemic to that region.

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CAMPANULACEAE

A NEW SPECIES OF *MERCIERA* FROM WESTERN CAPE, SOUTH AFRICA

INTRODUCTION

Merciera A.DC. is one of five Campanulaceae genera endemic to Western Cape. It is a genus of four dwarf shrub species, occurring in sandy, rocky or clayey habitats. Complex morphological variation render *Merciera* taxonomically challenging at the species level. Detailed morphometric analysis in *Merciera* (Cupido 2000) revealed the existençe of a well-defined group of specimens, which did not match any previously recognized taxon. This group of specimens was identified as *M. brevifolia* A.DC. The first known specimen was collected by Drège during the mid 1820s on the Du Toitskloof Mountains and was considered to be a member of *Roella* L., a genus closely related to *Merciera*. Floral characters of these plants display a clear interval in the morphological variation pattern within *M. brevifolia*. In addition to the distinct morphological characters, the plants also occupy a distinct geographical range, west of the Hottentots Holland Mountains in Western Cape. All the other species in the genus occur east of these mountains. This discrete group of specimens is described here as a new species.

Merciera tetraloba *C.N.Cupido*, sp. nov., ex affiniate *M. brevifolia* A.DC. et specierum affinum folia glabra in pagina abaxiale, calyx 4 lobis et ciliatis margines, corolla alba, interdum purpureus apice, lobis 4 ovatis, stamina 4 distinguenda.

TYPE.—Western Cape, 3418 (Simonstown): Strand, Harmony Flats, Tortoise Nature Reserve, off Disa Road, (–BB), 17 January 2000, *C.N. Cupido 77* (NBG, holo.; BM, K, MO, NY, PRE).

Subshrubs, hispidulous to hispid. *Stems* decumbent, slender, branched, occasionally with groups of branches at the end of a year's growth. *Leaves* alternate, linear, less than 8 mm long, subulate, entire, scattered, ascending, the older spreading, sessile, glabrous on abaxial surface, margins ciliate; axillary cluster of smaller leaves present. *Inflorescence* 3-flowered, 1 terminal, lateral 2 rudimentary, on highly reduced lateral branches with bract-like leaves, aggregated into spike-like synflorescences towards ends of main branches. *Flowers* sessile, axillary, actinomorphic. *Bract-like leaves* 2, succulent, subtending each of rudimentary flowers, absent in terminal flower, 1–4 mm long. *Hypanthium* obconical, 1–2 mm long, hispid with uncinate or circinate trichomes. *Calyx*: lobes 4, 0.6–1.2 mm long, fused at base to form short tube, hairs often on hyaline tips and margins. *Corolla* narrowly funnel-shaped, white, occasionally with purple tips, or very rarely pale blue; tube 4–6 mm long; lobes 4, ovate, glabrous or hairy on back, 2–3 mm long. *Stamens* 4, free, inserted at base of corolla tube; filaments flattened, wider and pilose about the middle, narrower towards apex, 3.0–4.5 mm long; anthers linear, basifixed. *Ovary* inferior, 1-locular, containing 4 erect ovules situated at base of ovary; style filiform, exserted, glabrous, swollen at base, 6–10 mm long; stigma bifid, glabrescent, bluish purple. *Fruit* a hispid capsule, crowned with persistent calyx, 1-seeded, indehiscent.

Flowering time: November to January, flowering most profusely in recently burnt veld (Figures 13 & 14).

Diagnostic features: the reduction in the number of calyx lobes, corolla lobes and stamens make *M. tetraloba* unique in the genus. This species differs from the other two white-flowered species, *Merciera leptoloba* A.DC. and *M. brevifolia*, in tetramerous flowers and calyx lobes often with marginal hairs. Furthermore, in *M. leptoloba* the corolla lobes are linear-lanceolate and the lower leaves are more than 8 mm long, whereas in *M. tetraloba* the corolla lobes are broadly ovate and the lower leaves less than 8 mm long. The other species in the genus, *Merciera tenuifolia* (L.f.) A.DC. and *Merciera eckloniana* Buek ex Ecklon & Zeyher, differ from *M. tetraloba* in having violet-blue flowers and corolla tubes of more than 7 mm long. The species is closely related to *M. brevifolia* from which it differs in floral characters and geographical distribution. The two species occur allopatrically. *M. brevifolia* is confined to mountains in Bot River, Houwhoek and Caledon, whereas *M. tetraloba* occurs west of the Hottentots Holland Mountains.

Distribution and habitat: this species is found in Faure, Gordon's Bay, Sir Lowry's Pass, Somerset West, Strand, Dal Josaphat, Du Toitskloof and Stellenbosch (Figure 15) on flats and lower mountain slopes at altitudes between 30 m and 350 m. It grows in open clayey soil, often in disturbed habitats.

Large areas of the habitat of this species in the Helderberg and Stellenbosch areas have been destroyed because lower mountain slopes and lowland areas are sought after for urban development. On the Harmony

FIGURE 13.—*Merciera tetraloba*, inflorescences, × 0.75. Photograph by J.C. Manning.

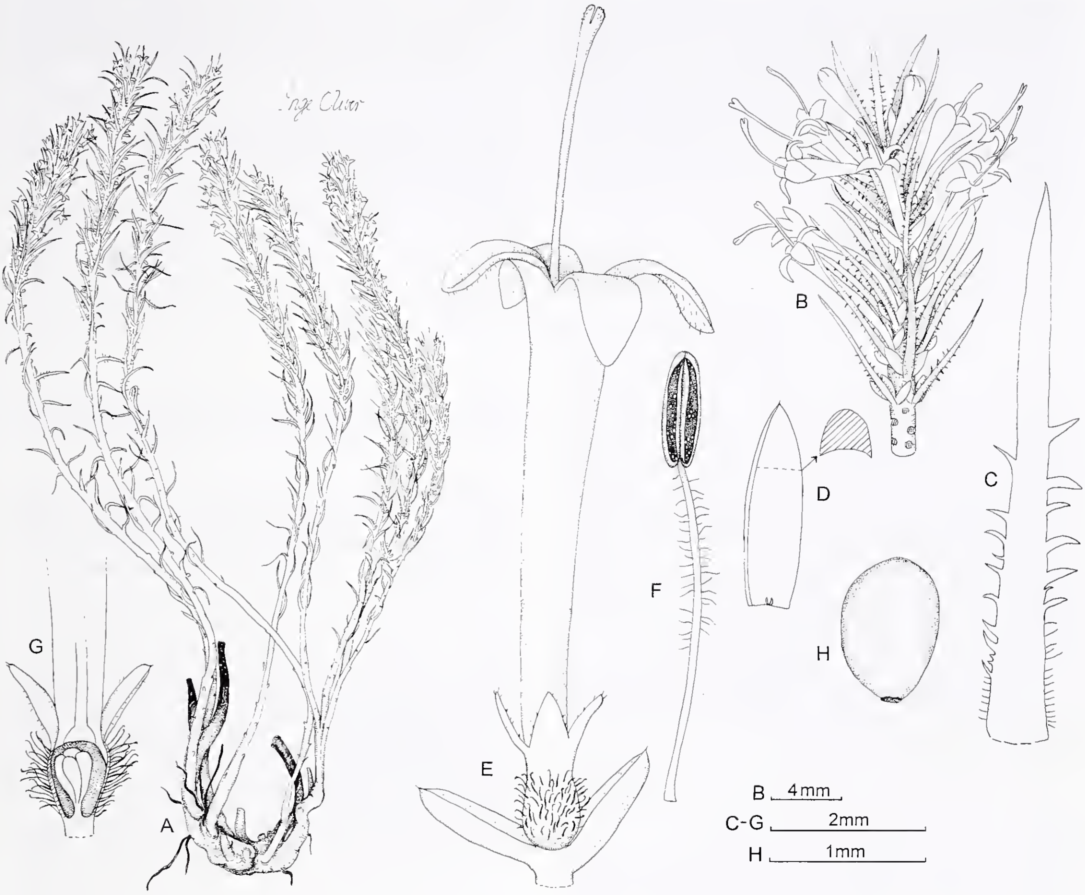

FIGURE 14.—*Merciera tetraloba*. A, portion of plant, life size; B, flowering branch; C, leaf; D, bract-like leaf with rudimentary flower; E, flower with two bract-like leaves; F, stamen; G, base of flower longitudinally opened, showing ovary and basal part of style; H, seed. Drawn from *Cupido 77* by Inge Oliver. Scale bars: B, 4 mm; C–G, 2 mm; H, 1 mm.

Flats in Strand, the few existing populations are under serious threat of extinction.

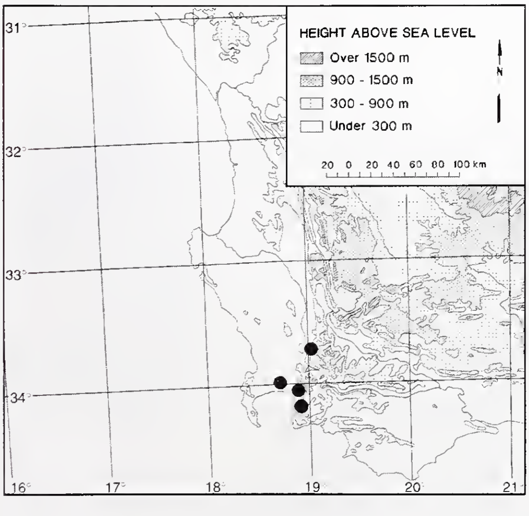

FIGURE 15.—Known distribution of *Merciera tetraloba*.

Etymology: the name of this species is derived from the respective number of lobes in the corolla and calyx (*tetra* = four, *lobi* = lobes).

Specimens examined

WESTERN CAPE.—3318 (Cape Town): Dal Josaphat, (–DB), *Barker 8865* (NBG), on hills, *Tyson 899* (SAM); between Bottelary and Stellenbosch, (–DD), *Bolus BOL*98256 (BOL); near roadside Stellenbosch, *Markotter 8639* (NBG); Stellenbosch Mountain, lower western slopes above the university farm and NE of Brandwacht suburb, *Oliver & Oliver 11866* (NBG). 3319 (Worcester): Du Toitskloof, (–CC), *Drège SAM17297* (SAM). 3418 (Simonstown): Sir Lowry's Pass, foot of pass, (–BB), *Adamson 4895* (BOL); Sir Lowry's Pass, foot of pass on the Somerset West side, *Cupido 117* (NBG); Sir Lowry's Pass, *Guthrie 2792* (NBG); Faure Hills, *Compton 10372* (NBG); Gordon's Bay, mountain slopes above, *Bayliss 4089* (NBG); flats between Strand and Gordon's Bay, *Jordaan s.n.* (NBG); Somerset West, *Parker 3550* (NBG); Strand, upper Harmony Flats between Lwandle Township and Strand Foam Factory, *Boucher 3447* (NBG); Strand, Tortoise Nature Reserve, *Cupido 75, 77* (NBG).

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I wish to thank the following people for their assistance: Prof. H.P. Linder for supervising the project;

Mrs P. Runnalls of the Friends of Helderberg Nature Reserve for finding a population of the living plants for me, after my own futile attempts; Ferozah Conrad for assistance with the Latin diagnosis; the curator of the Bolus Herbarium for making their specimens available for the study; Mrs I. Oliver for doing the line drawings and Dr J.C. Manning for taking the photograph.

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ERIOSPERMACEAE

VALIDATION OF TWO SECTIONAL NAMES IN *ERIOSPERMUM*

Perry's revision of *Eriospermum* (1994) included a new infrageneric classification of the genus with new infrageneric taxa being formally described. However, two of the new sectional names were invalidly published due to the lack of typification (Art. 37.1 St Louis Code; Greuter *et al.* 2000). Although this omission was mentioned in the *Index kewensis* (IK) as available in the CD-Rom version, or within the International Plant Names Index (IPNI) internet database, no action has been taken to validate the names. Consequently, both names are validated here:

Eriospermum [subgenus **Ligulatum**] section **Ligulatum** *P.L.Perry ex Thiede*, sect. nov. Type: *Eriospermum flagelliforme* (Baker) J.C.Manning.

For the Latin diagnosis see Perry in *Contributions from the Bolus Herbarium* 17: 77 (1994).

Eriospermum flagelliforme is the correct name for the species previously known as *Eriospermum abyssinicum* Baker (Manning 2000).

Eriospermum [subgenus **Cyathiflorum**] section **Cyathiflorum** *P.L.Perry ex Thiede*, sect. nov. Type: *Eriospermum cooperi* Baker.

For the Latin diagnosis see Perry in *Contributions from the Bolus Herbarium* 17: 120 (1994).

The 'description' of *Eriospermum* [subgenus *Eriospermum*] section *Eriospermum* P.L.Perry [in tom. cit. 160] was superfluous under Art. 22.3 St Louis Code (Greuter *et al.* 2000) and consequently not included in IK.

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THYMELAEACEAE

A NEW SPECIES OF *PASSERINA* FROM WESTERN CAPE, SOUTH AFRICA

INTRODUCTION

Passerina L. comprises about 20 species and four subspecies of evergreen perennial shrublets (Thoday 1924; Goldblatt & Manning 2000). Most members are confined to the Cape Floristic Region with its Mediterranean or semi-Mediterranean climate. Three species extend northwards along the Great Escarpment, with *P. montivagus* Bredenkamp & A.E.van Wyk extending northwards to Tanzania. Under the heading 'Incertae', Thoday (1924) discussed specimens of doubtful identity, most of them from mountain summits and outlying localities. He concluded that further collecting would solve the problem of their identification. Here we describe a new species confined to high altitudes on some of the mountains in the western sector of the Cape Floristic Region and the adjacent Roggeveld Escarpment. The separate specific status of the new taxon is supported by evidence derived from the epidermal structure (Bredenkamp & Van Wyk 1999, 2000), leaf anatomy (Bredenkamp & Van Wyk 2001a) and vegetative and floral morphology (Bredenkamp & Van Wyk 2001b).

MATERIAL AND METHODS

All collections of *Passerina* from 22 herbaria were studied for taxonomy and external morphology. Specimens of the new species were found in the following herbaria (acronyms according to Holmgren *et al.* 1990): BOL, K, NBG, PRE.

For leaf anatomy, both fresh and herbarium material were studied. Vouchers used in anatomical studies: *Bredenkamp 1044–1047; Goldblatt & Manning 8627;*

Oliver 9281. Methods used in the study of leaf structure are described in Bredenkamp & Van Wyk (1999, 2000, 2001a).

Passerina nivicola *Bredenkamp & A.E.van Wyk*, sp. nov., *P. comosae* C.H.Wright affinis sed bracteis circumscriptione late obovatis, basi cuneatis, rubrofusis in alabastro, lamina utrinque glabra, chartacea, alis bullatis, membranaceis, marginibus ciliatis dimidio superiore, costa crassa, ventraliter tomentosa in apicem subacutum extensa, caespite apicali pilorum. *Hypanthium* circa ovarium extra tomentoso. *Sepala* tempore pollinationis membranacea, lutea vel luteorosea; sepalis, exterioribus apice setosis, sepalis interioribus utrinque glabris.

TYPE.—Western Cape, 3319 (Worcester): Ceres Dist., Waboomberg, 1 760 m, (–DD), 12 November 1989, *E.G.H. Oliver 9281* (PRE, holo.; NBG, iso.).

Rounded evergreen shrublets 0.3–0.5 m high. *Stems* greyish brown, younger branchlets greyish tomentose, cork finely fissured, grey-brown. *Leaves* decussate, imbricate on young branchlets, sessile, closely adpressed to stem, cymbiform, cylindric, often slightly dilated apically, linear-lanceolate, (2.5–)3.1(–4.5) × (0.5–)0.6(–0.7) mm, inversely ericoid; adaxial surface concave, tomentose; abaxial surface convex, glabrous; apex rounded, with tuft of trichomes, tinged red; base sessile; margin sometimes ciliate. *Inflorescences* composed of polytelic synflorescences; main florescences as well as co-florescences spicate. *Bracts* tinged red in bud stage, enveloping flowers and fruits, largest after anthesis, becoming more coriaceous and rounded at fruit set, decussate, imbricate, cymbiform; lamina rolled, widely obovate, length × $^1/_2$ width (3.1–)3.5 × 1.4(–1.9) mm, adaxially (inside) concave, abaxially (outside) convex and glabrous, midrib tomentose on inside, chartaceous; base cuneate; main vein strongly developed, extending to form subacute apex, with apical tuft of trichomes; wings glabrous, bullate, membranous; margin ciliate in upper half. *Pedicel* very short or absent. *Receptacle* very short. *Floral envelope* petaloid, up to 5.3 mm long, membranous and yellow or yellow-pink during pollination, papyraceous and turning red after pollination; hypanthium tomentose at ovary, neck ± 1.2 mm long, tomentose on outside, often hairy inside, articulation at neck base absent because of lack of abscission tissue, fragmentation of neck base caused by dehydration and torsification of tissue after fruiting, resulting in shedding of sepals and androecium; sepals 4, imbricate in bud, flexed in flower, outer sepals cymbiform, abaxially setose at apex, inner sepals widely ovate, glabrous. *Corolla* absent. *Petaloid scales* absent. *Disc* absent. *Androecium* dimorphic diplostemonous, arising from hypanthium at separation point of sepals; filaments of antipetalous whorl ± 0.4 mm long, those of antisepalous whorl ± 1.2 mm long; pollen grains shed as monads, spheroid, pantoporate, basal reticulum of typical crotonoid pattern no longer discernible, replaced by secondary reticulum derived from fused sexine (Bredenkamp & Van Wyk 1996). *Ovary* superior, ± 1.7 × 0.5 mm, pseudomonomerous, uniloculate, with one pendulous ovule laterally attached near top of ovary, placentation parietal; ovule anatropous, position ventrally epitropous, bitegmic, with exotegmic palisade, crassinucellate, obturator of elongate cells extending from base of style to mi-cropyle; stigma developing at base of sepals, penicillate. *Fruit* a 1-seeded berry, pericarp membranous and dry, enveloped by persistent, loosely arranged hypanthium fragmented at neck base. *Seed* broadly fusiform with outgrowths at both micropylar and funicular ends, ± 2.2 × 1.2 mm, tegmen black and shiny; endosperm formation nuclear, but later becoming cellular throughout. Figure 16.

Leaf anatomy

Leaf structural type A: *leaf* isobilateral. *Main vascular bundle* central; bundle sheath completely enclosing vascular tissue. *Secondary vascular bundles* close, with bundle sheaths adhering, forming a central plate of veins. *Sclerenchymatous hypodermal sheath* absent. (Bredenkamp & Van Wyk 2001a).

Leaf isobilateral, outline in transverse section (t/s) transversely elliptic. *Adaxial epidermis*: cuticular membrane (CM) ± 3 μm thick; periclinal × anticlinal cell diameters in t/s 25 × 40 μm; stomata often dispersed in

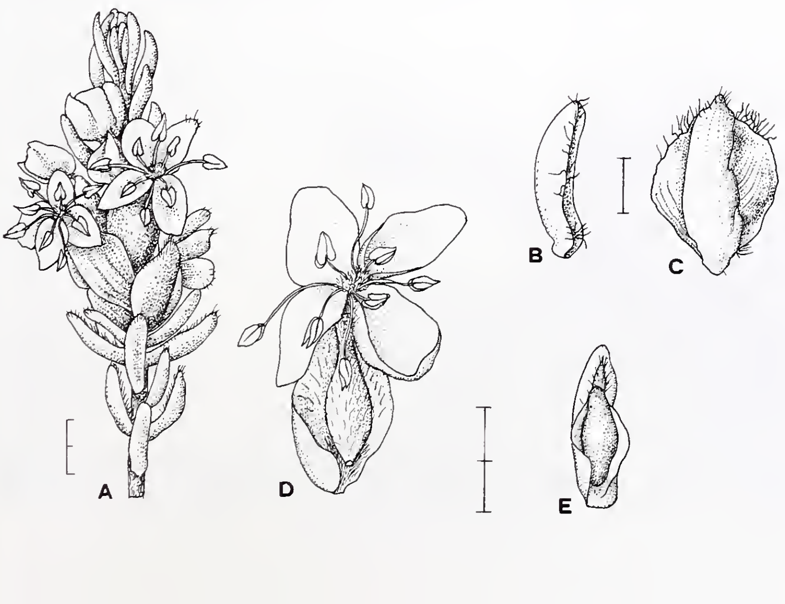

FIGURE 16.—*Passerina nivicola*, *Oliver 9281*: A, inflorescence; B, leaf; C, bract; D, flower clasped by bract; E, fruit enveloped by persistent floral bract. Scale bars: A, D, E, 2 mm; B, C, 1mm.

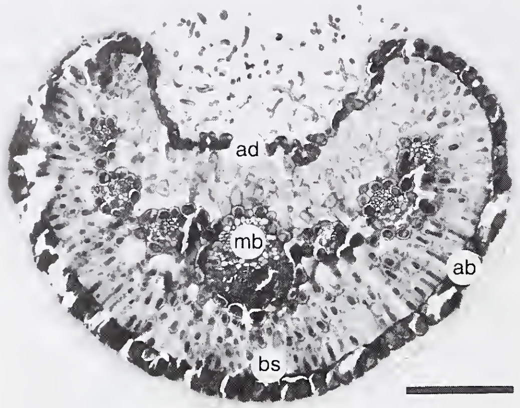

FIGURE 17.—*Passerina nivicola*, *Bredenkamp 1044*: leaf structural type A, t/s; leaf isobilateral, vascular bundles closely arranged, bundle sheaths adhering, forming central plate of veins. ad, adaxial epidermis; ab, abaxial epidermis; bs, bundle sheath; mb, median vascular bundle. Scale bar: 100 µm.

two columns in adaxial epidermal folds, with ± 3–5 rows of epidermal cells in between, sunken or arranged in stomatal crypts. *Abaxial epidermis*: cuticular ornamentation comprising several domes per cell, CM ± 20 µm thick, irregularly marked by grooves, wax platelets scarce, geometrical, flat or raised, with rounded to sharp edges; cells arranged in rows, oblong, pentagonal–heptagonal, dimensions in surface view 45–55 × 35–40 µm, periclinal × anticlinal cell diameter in t/s 35–40 × 40–55 µm. *Mesophyll* consisting of ± 3 adaxial and 4 abaxial layers of ± homogeneous, palisade-like parenchyma cells; density 3 or 4 cells per 50 µm; intercellular spaces surrounding central veins. *Main vascular bundle* 410–450 µm thick, 810–850 µm wide, widely ovate with ample extraxylary fibres. *Bundle sheath* consisting of ± 19–25 parenchymatous cells, completely enclosing vascular tissue, cells rounded, transversely or longitudinally elongated. *Secondary vascular bundles* forming central plate of 3 or 4 veins on each side of main bundle. Figure 17.

Diagnostic characters and relationships: *Passerina nivicola* is superficially similar to *P. comosa*, but differs from it by its glabrous leaves and red-tinged bracts, which are glabrous outside, with bullate, membranous wings. The flowers of the new species are membranous and yellow or yellow-pink at pollination, with outer sepals abaxially setose at the apex and the inner sepals glabrous on both surfaces.

Etymology: the specific epithet is a compound of the Latin *nivalis* (= pertaining to snow) and *cola* (= dweller), thus *nivicola* = a dweller in the snow. The name alludes to the occurrence of this species at high altitudes, where the plants are periodically covered by snow.

Distribution and ecology: because of its confinement to mountainous areas *P. nivicola* is clearly still under-collected. The most northerly record is from Sneeukrans on the Roggeveld Escarpment, where it is associated with Escarpment Mountain Renosterveld (Rebelo 1998). Most records are from the Ceres and Worcester Districts (Figure 18), with plants occurring in either Mountain Fynbos or Central Mountain Renosterveld (Rebelo 1998).

The new species was found on Waboomberg near Ceres growing at an altitude range of 1 200–1 760 m and although it was summer, the plants were dug out from under a layer of snow (Figure 19). Here the plants occur in low restioid or graminoid veld on sandy loamy soil. They are somewhat stunted and attain a height of ± 0.3 m, possibly because of the effects of snow. The same species is also found lower down, next to the road leading to the mountain, where the plants are more robust and reach a height of up to 0.5 m; the floral bracts are more coriaceous. Accessible plants are grazed by stock. Information from *Grobler 540*, indicates that this species also occurs on shale flats at Kareevlakte in Ceres.

Conservation status: Least Concern [LC] (IUCN Species Survival Commission 2000).

Specimens examined

NORTHERN CAPE.—3220 (Sutherland): Roggeveld Escarpment, Quaggasfontein Farm, on road to Uitkyk, Sneeukrans W of Sutherland, (–AB), *Goldblatt & Manning 8627* (PRE).

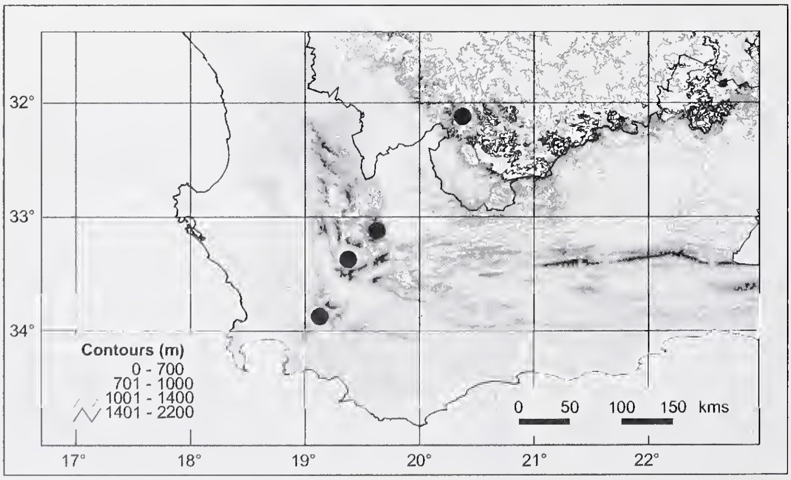

FIGURE 18.—Known distribution of *P. nivicola*.

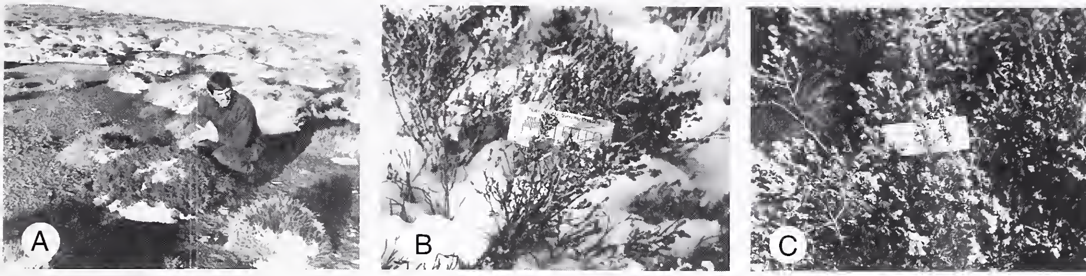

FIGURE 19.—Typical habitat of *P. nivicola*: A, rounded shrublets covered in snow on level area close to summit of Waboomberg, near Ceres; B, individual stunted plants, ± 0.3 m high; C, plants flowering lower down mountain.

WESTERN CAPE.—3319 (Worcester): Ceres, Kareevlakte, (–AD), *Grobler 540* (PRE); Ceres, Waboomberg, Farm Merino, (–AD), *Bredenkamp 1044–1047* (PRE); vlei N of FM tower, *Cillie 9* (NBG); level area S of beacon, *Oliver 9281* (NBG, PRE); Ceres, Baviaansberg, (–BA), *Compton 8718* (NBG); Worcester Dist., Tafelberg, (–CC), *Pillans 17159* (BOL, K), *s.n.* (K).

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THYMELAEACEAE

A NEW SPECIES OF *GNIDIA* FROM THE KNERSVLAKTE, WESTERN CAPE, SOUTH AFRICA

Gnidia pedunculata *Beyers*, sp. nov., *Gnidia polycephala* (C.A.Mey.) Gilg similis sed ab ea pedunculo plerumque longo, involucralibus bracteis coriaceis abaxiale glabris, floribus quadrimeris squamis quarternis carnosis petaloideis differt.

TYPE.—Western Cape, 3118 (Vanrhynsdorp): Knersvlakte, Olifants River Settlement 316, near Eastern border, (–BC), 6-08-1993, *Le Roux & Hilton-Taylor 27* (NBG, holo.; K, PRE).

Erect dwarf shrub up to 0.25 m tall. *Branches* ascending, later becoming woody, glabrous, densely leafy, later becoming naked with prominent leaf scars. *Leaves* alternate, ascending, densely imbricate below, becoming distant above, petiolate, glabrous; blade oblanceolate, 4.8–7.8 × 0.5–1.4 mm, subfleshy, enervate, ad- and abaxially flat, apex obtuse or subacute; petiole 0.3–0.4 mm long. *Inflorescence* terminal, indeterminate, bracteate umbel with up to 14 mature flowers at a time; flower development sequential—fruiting stages present with young buds developing within; peduncle 10–30 mm long, glabrous. *Involucral bracts* 5 or 6, ovate or elliptic, 7–10 × 3–6 mm, green or green with maroon tinge, coriaceous, faintly nervate, adaxially shortly adpressed hairy, abaxially glabrous, apex rounded or subacute. *Flowers* subactinomorphic, yellow, strongly scented. *Pedicel* 1.3–2.0 mm long, adaxially sericeous, abaxially densely covered with short, silky, spreading hairs. *Hypanthium* 9.5–22.0 mm long, circumscissile 3.5–5.0 mm from base, upper portion narrowly funnel-shaped, covered with short crisped hairs becoming sericeous towards apex, basal portion narrowly ovate, densely covered with long, silky, ascending hairs. *Sepals* 4, narrowly elliptic, 2.9–3.6 × 1.0–2.2 mm, adaxially glabrous, abaxially sericeous, margin recurved, apex rounded. *Petaloid scales* 4, inserted at rim of hypanthium alternate to sepals, fleshy, narrowly oblong to oblong, narrowly elliptic to

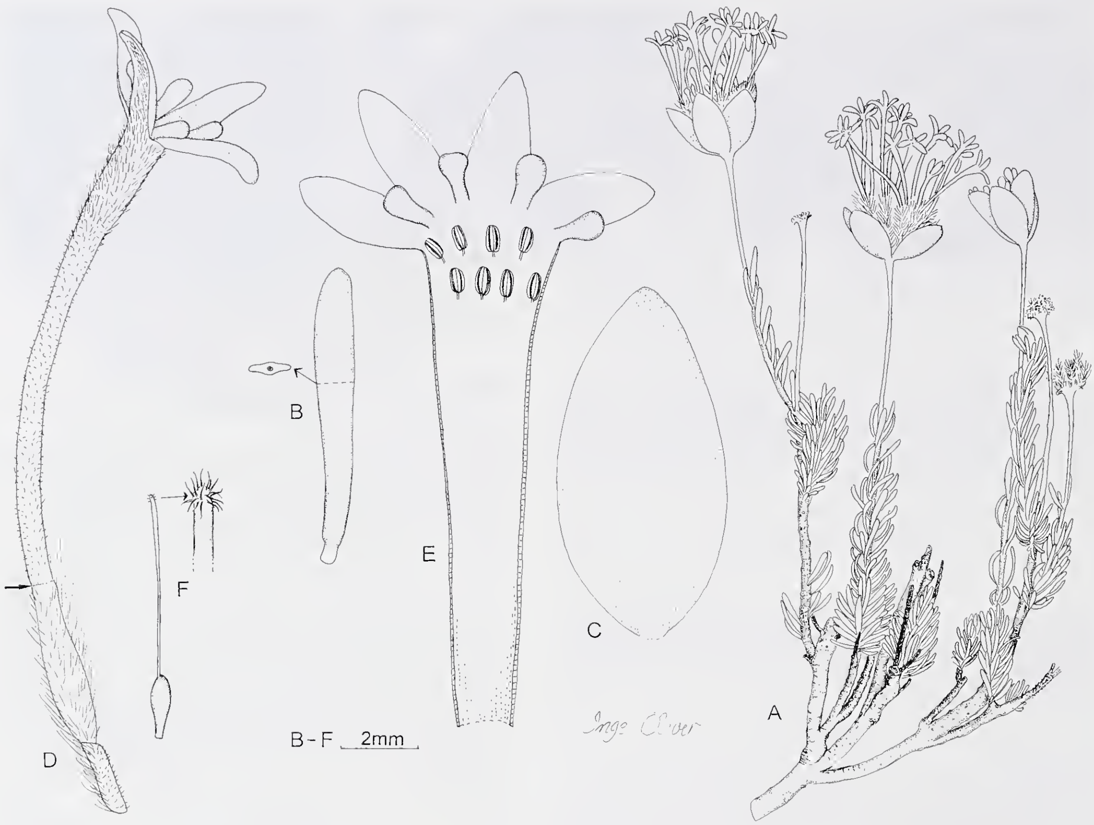

FIGURE 20.—*Gnidia pedunculata*, *Le Roux & Hilton-Taylor 27* (NBG). A, portion of plant, × 1; B, leaf, abaxial view and c/s; C, involucral bract, abaxial view. D, E, flower: D, side view, circumscission zone arrowed; E, l/s above circumscission zone with gynoecium removed. F, gynoecium and stigma enlarged. Scale bars: B–F, 2 mm.

elliptic, obovate or spathulate, 0.9–1.6 × 0.5–0.6 mm, apex rounded or obtuse, glabrous. *Stamens* 4 + 4, subsessile; outer whorl semi-exserted, inserted just below rim of hypanthium; inner whorl included, inserted a short way down throat of hypanthium; filament 0.1–0.2 mm long; anthers introrse, ellipsoid, 0.5–0.9 × 0.3–0.5. *Ovary* narrowly ellipsoid, attenuated at base, 1.6–3.6 × 0.5–0.9 mm, glabrous, unilocular with single, pendulous ovule; style filiform, inserted laterally on ovary, included, 4.8–5.0 mm long, glabrous; stigma penicillate. *Fruit* an achene, enclosed in persistent base of hypanthium. *Flowering time*: August. Figure 20.

This species at first glance appears similar to *Gnidia polycephala* (C.A.Mey.) Gilg which also has alternate leaves, a terminal, indeterminate, bracteate umbel with involucral leaves much broader than the cauline leaves and yellow sericeous flowers. It, however, differs from *G. polycephala* by the usually well-developed peduncle, the coriaceous involucral bracts which are glabrous abaxially and the four-merous flowers with four, fleshy, petaloid scales. In *G. polycephala* there is no well-developed, naked peduncular region, the papery thin involucral bracts are adpressed hairy abaxially, the flower is pentamerous and the petaloid scales are absent.

Gnidia pedunculata has only been recorded from the Knersvlakte north of Vredendal, growing in Succulent Karoo vegetation in well-drained, sandy, loam soil. Figure 21.

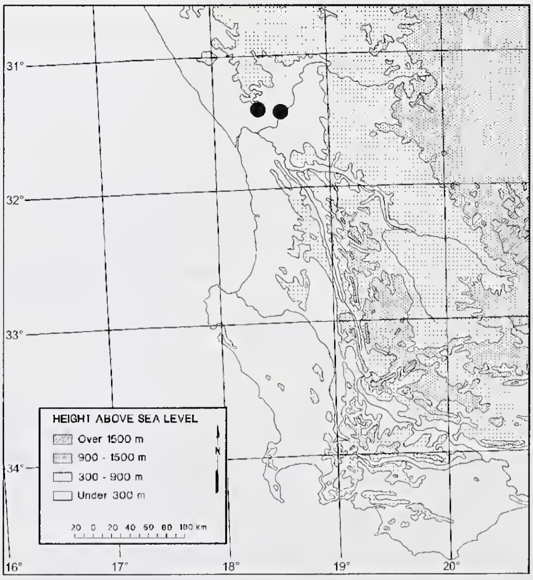

FIGURE 21.—Geographical distribution of *Gnidia pedunculata*.

The usually well-developed, naked peduncles in this species prompted the specific epithet which is derived from the Latin, *pedunculatus*.

Paratype material

WESTERN CAPE.—3118 (Vanrhynsdorp): Knersvlakte, Moedverloor, near river on steep slope, (–AD), 31-08-2001, *Schmiedel 118546* (NBG).

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LAMIACEAE

NEW COMBINATIONS IN THE GENUS *ROTHECA* IN SOUTHERN AFRICA

The genus *Clerodendrum* L. was divided into a number of different sections or subgenera by Gürke (1895), Pearson (1912) and Thomas (1936) on the basis of *inter alia* the flower symmetry. In the past, some of these sections or subgenera were considered to be independent genera, e.g. the genus *Cyclonema* Hochst. (1842). Steane *et al.* (1997) showed that *Clerodendrum sens. lat.* is polyphyletic and that *Cyclonema* should be reinstated as a genus. Steane & Mabberley (1998) revived the genus *Rotheca* Raf. for taxa under the subgenus *Cyclonema* (Hochst.) Thomas and/or sections *Cyclonema* (Hochst.) Gürke and *Konocalyx* Verdc. of the genus *Clerodendrum* on the grounds of the corolla (flower) symmetry, anther attachment and stigma symmetry. More new combinations for taxa from the *Flora zambesiaca* and *Conspectus florae angolensis* areas were made by Fernandes & Verdcourt (2000).

A number of new combinations for taxa occurring in southern Africa, not covered by the above-mentioned publications, are presented here:

Rotheca caerulea (*N.E.Br.*) *P.P.J.Herman & Retief*, comb. nov.

Clerodendrum caeruleum N.E.Br. in Kew Bulletin 1895: 115 (1895). Type: [KwaZulu-]Natal, Mooi River Valley, *Gerrard 1252* (K).

Rotheca cuneiformis (*Moldenke*) *P.P.J.Herman & Retief*, comb. nov.

Clerodendrum cuneiforme Moldenke in Phytologia 59: 119 (1986). *C. cuneatum* Gürke: 303 (1900), nom. illeg., non Turcz.: 221 (1863). Type: Transvaal [Mpumalanga], Lydenburg, *Wilms 160* (?B).

C. scheffleri Gürke var. *ellipticum* Moldenke: 417 (1940). Type: [KwaZulu-]Natal, Durban, *Evans 544a* (NH).

Rotheca louwalbertsii (*P.P.J.Herman*) *P.P.J.Herman & Retief*, comb. nov.

Clerodendrum louwalbertsii P.P.J.Herman in Bothalia 25: 100 (1995). Type: Transvaal [Northern Province], between Nylstroom and Warmbaths, *Germishuizen 3343* (PRE, holo.!).

Rotheca pilosa (*H.Pearson*) *P.P.J.Herman & Retief*, comb. nov.

Clerodendrum pilosum H.Pearson in Transactions of the South African Philosophical Society 15: 181 (1905). Type: [Eastern Cape], Kentani, *Pegler 164* (PRE!).

Rotheca uncinata (*Schinz*) *P.P.J.Herman & Retief*, comb. nov.

Clerodendrum uncinatum Schinz in Verhandlungen des Botanischen Vereins der Provinz Brandenburg 31: 206 (1889). *Kalaharia uncinata* (Schinz) Moldenke: 132 (1955). Type: South West Africa [Namibia], Goroxas, *Schinz 1890* (?Z).

C. spinescens (Oliv.) Gürke:180 (1893), nom. illeg.

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MARSILEACEAE–PTEROPSIDA

FIRST REPORT OF THE GENUS *PILULARIA* FROM CONTINENTAL AFRICA

Pilularia L. is a genus of five poorly defined species. Two species, *P. globulifera* L. and *P. minuta* A.Braun have a European distribution, whereas *P. americana* A.Braun (incl. *P. mandoni* A.Braun) occurs in North and South America. One species each occurs in Australia (*P. novae-hollandiae* A.Braun) and New Zealand (*P. novae-zelandiae* Kirk). Hitherto no taxa belonging to the genus have been recorded for the African continent.

Recently, however, I collected a species of *Pilularia* in Northern Cape, South Africa. An assessment of *P. americana*, *P. novae-hollandiae* and *P. novae-zelandiae* by Large & Braggins (1989) shows that these species all have four locules in each sporocarp, rather than the two locules per sporocarp recorded for the European taxa. Due to a lack of suitable characters and the large overlap in diagnostic features between these species, Large & Braggins (1989) concluded that some of the names might have to be placed in synonymy.

A study of the South African specimen showed that it also has four locules in each sporocarp, thus making it part of the *P. americana* group of species. Other congruent features the South African specimen has with the *P. americana* group of species include frond length, pedicel length, sporocarp size, and number of megasporangia per locule, micro- and megasporangia size as well as epispore ornamentation. For this reason the oldest valid name for the taxon, *P. americana*, is tentatively applied to the South African *Pilularia* species.

Pilularia americana *A.Braun* in Monatsberichte der Königlichen Akademie der Wissenschaften zu Berlin 15: 435 (1864). Type: North America, Fort Smith, on the Arkansas River, *Thomas Nuttall s.n.* (Holotype not located; NY, iso.).

Plants terrestrial. *Rhizome* with single unbranched stele, creeping, irregularly branched, up to 0.5 mm diam., set with single root or root clusters at nodes, roots unbranched, internodes up to 11 mm long, initially sparsely haired, glabrous with age, mostly with a few hairs at frond base, hairs up to 5 cells long, laterally attached. *Fronds* with single unbranched stele, borne singly at nodes, erect, simple, terete, up to 19 mm long, basally with few laterally attached, 2-celled hairs, glabrous higher up; stomata of aperigenous type, (34.0–)39.23(–44.0) μm long. *Sporocarp* globose, up to 2.5 mm diam., laterally attached, 4-locular, densely haired, hairs up to 5 cells long, epigeal at maturity; venation catadromous, pinnately branched, each locule has 3-veined vascular supply, central vein bearing a sorus near branching point containing micro- and megasporangia; veins free or anastomose at distal end of sporocarp; sporocarp pedicel arises at node on rhizome, with single unbranched stele, up to 2 mm long, initially growing downwards, twisted and burying sporocarps in substrate. *Microsporangia* clavate, several per sorus, wall one cell layer thick, hyaline, each bearing 23–32 microspores. *Microspores* trilete, spherical in polar view, asymmetric in lateral view, laesura straight or curved, perispore hya-

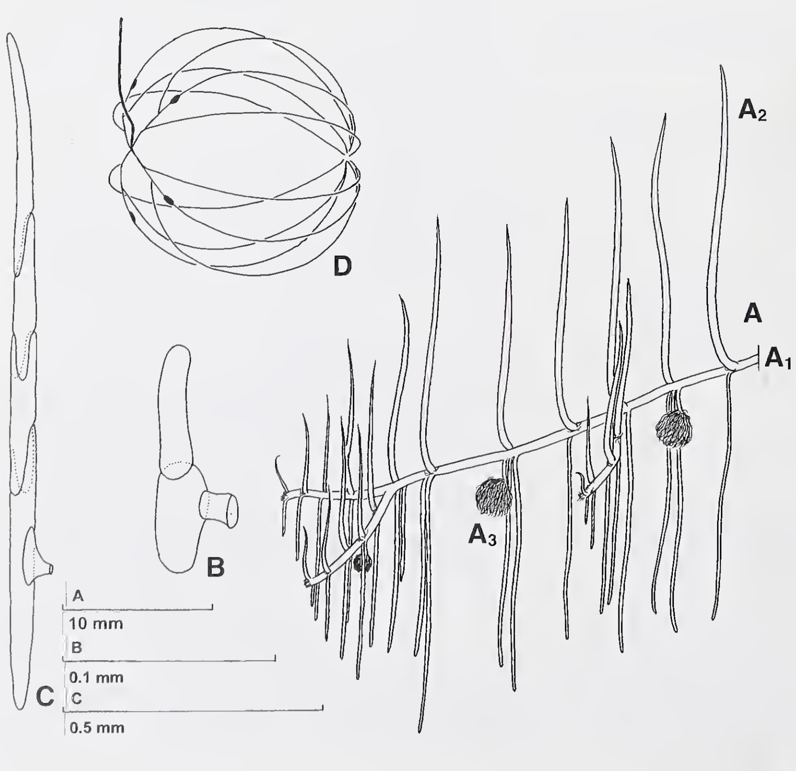

FIGURE 22.—*Pilularia americana* A.Braun. A, habit: A_1, rhizome; A_2, frond; A_3, sporocarp and cluster of roots. B, lamina hair; C, sporocarp hair; D, sporocarp venation showing position of sori. Scale bars: A, 10 mm; B, 0.1 mm; C, 0.5 mm; D, not to scale. Drawn by J.P. Roux.

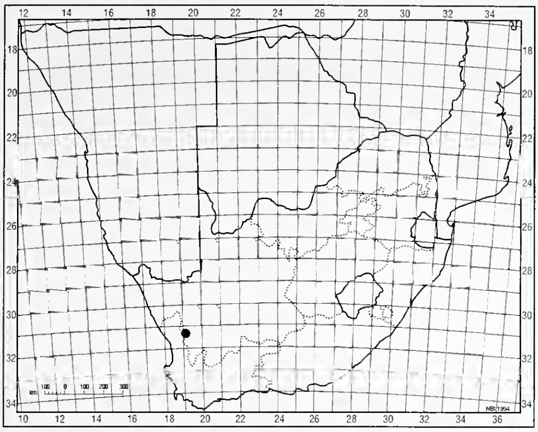

FIGURE 23.—Distribution of *Pilularia americana* in southern Africa.

line, larger than spore, epispore thicker on distal face, densely and finely rugulate, exospore (32.0–)34.87(–36.0) μm diam. *Megasporangia* globose, wall one cell layer thick, hyaline, 8–17 per sorus, each bearing a single megaspore. *Megaspores* globose in polar and lateral view, with prominent ridged papilla up to 104 μm long, perispore hyaline, much larger than megaspore, epispore thicker around papilla and at distal pole than at equator, finely and deeply folded giving it a finely rugulate appearance, exospore up to 360 μm diam. Figure 22A–D.

Specimen examined

NORTHERN CAPE.—3119 (Calvinia): Nieuwoudtville, in seasonal pan, (–AC), 10 October 2001, *J.P. Roux 3156* (NBG).

Distribution and ecology

Pilularia americana was recorded from the edge of a seasonal pan on the Bokkeveld Escarpment, an area of low rainfall (500–650 mm per annum) which occurs during winter and spring (June–September) (Figure 23). Sandstone beds of the Cape System are the dominant geological formation in the region and support fynbos vegetation.

Until a thorough study of the distribution of the species and population size has been done, its conservation status should be considered as data-deficient (IUCN 1994).

ACKNOWLEDGEMENTS

My thanks to Dr J.T. Mickel who verified the presence of the isotype in the New York herbarium.

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Bothalia 32,1: 85–89 (2002)

The taxonomic significance of trichome type and distribution in *Melolobium* (Fabaceae)

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Keywords: Fabaceae, *Melolobium* Eckl. & Zeyh., sessile glands, stalked glands, trichomes, uniseriate hairs

ABSTRACT

All species of *Melolobium* Eckl. & Zeyh. were examined for epidermal features and particularly the glands which are a distinctive feature amongst the southern African Genisteae. For comparative purposes, three species of *Argyrolobium* Eckl. & Zeyh., all five species of *Dichilus* DC. and five species of *Polhillia* C.H.Stirt. were also examined for trichome type and distribution. Three trichome types are recognized in *Melolobium*. Trichome type and distribution provide an important insight into taxonomic relations at species level in *Melolobium* and sometimes even allow a distinction between regional forms. The distribution of glands (sessile and stalked) is of considerable diagnostic value in identifying species of *Melolobium*. A key to all the species of the genus based mainly on type and distribution of trichomes, is presented.

INTRODUCTION

Melolobium Eckl. & Zeyh. is a papilionoid legume genus restricted to southern Africa. Although about 20 species have been described, we recognize only 15 of them (a complete synonymy will be published elsewhere). The genus consists of small shrubs or perennial herbs, characterized by their usually spiny habit, auriculate stipules and bilabiate calyces. Some species have glandular trichomes, referred to as glandular papillae by Gibbs (1967), glandular tubercles by Polhill (1976) and stipitate glands by Harvey (1862). Glands are also characteristic of the Mediterranean genus *Adenocarpus* DC. *Melolobium* and related genera were originally placed in the tribe Genisteae (Harvey 1862), then transferred to Crotalarieae (Bentham 1865; Polhill 1976, 1981), and finally moved back to Genisteae by Van Wyk & Schutte (1995), where they are now firmly placed.

In the latest available revision of the genus, Harvey (1862) used hairs and glands as diagnostic characters, but the full extent of the variation, especially at microscopic level, has not yet been studied. The aims of this study were: to determine the taxonomic potential of epidermal features in *Melolobium* (at both species and generic levels); to record the microscopic structure of hairs and glands in this genus; and to determine the homology of glands in *Melolobium* and *Adenocarpus*.

MATERIALS AND METHODS

Hair type and distribution were investigated in all 15 of the species of *Melolobium* that we recognize, as well as in three species of *Argyrolobium* Eckl. & Zeyh., all five species of *Dichilus* DC. and five of the seven species of *Polhillia* C.H.Stirt. A list of voucher specimens of all species of *Melolobium* and the related African genistoid genera used in this study is given in Table 1. For light microscope studies, material taken from formalin: acetic acid: alcohol (FAA) and herbarium specimens was embedded in glycol methacrylate (GMA) according to a modification of the method of Feder & O'Brien (1968). This modification involves infiltrating the material for a minimum of 24 hours between the first two changes and for a longer period (usually at least five days) before placing in the gelatine capsules, which are then heated in the oven at 60° C for 24 hours to polymerize. A Porter Blum MT-1 ultramicrotome was used for sectioning and the sections were stained according to the periodic acid-Schiff/Toluidine Blue (PAS/TB) staining method. For epidermal peels, pieces of leaves were treated according to the method of Ram & Nayar (1974). To study trichome distribution, several specimens of each taxon were examined with a stereomicroscope. For SEM studies of trichomes, herbarium or washed, air-dried FAA material was used and at least two specimens of each taxon were examined using a JEOL JSM 5600 scanning electron microscope.

RESULTS AND DISCUSSION

Trichome type

Trichome type and distribution in *Melolobium* and related African genera are summarized in Table 2. Three trichome types were recognized in *Melolobium*: uniseriate hairs with a long narrow terminal cell and two or three short basal cells (Figure 1A, B, D, E); stalked glands with a unicellular head and a multicellular stalk (Figures 2A–D; 4C); and sessile glands (Figure 3). Uniseriate hairs occur in all species of *Melolobium* [except in *M. exudans* Harv. and *M. lampolobum* (E.Mey.) A.Moteetee & B.-E.van Wyk which are glabrous], *Dichilus* and in all the examined species of *Argyrolobium* and *Polhillia*. The two types of glands are found only in *Melolobium*.

In the subfamily Papilionoideae, uniseriate hairs consist of three cells: a frequently enlarged epidermal cell, serving as a basal cell; a short stalk cell, which occasionally has special contents and is suberized; and an elongated terminal cell (Solereder 1908). In *Melolobium*,

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TABLE 1.—Voucher specimens of *Argyrolobium*, *Dichilus*, *Melolobium* and *Polhillia* examined for trichome characters

Taxon	Voucher
Melolobium	
adenodes Eckl. & Zeyh.	*Dean 756** (JRAU); *Van Wyk 3070, 4036* (JRAU)
alpinum Eckl. & Zeyh.	*Moteetee & Van Wyk 5* (JRAU); *Schutte 158*, 332* (JRAU)
aethiopicum (L.) Druce	*Van Wyk 2452*, 2685*, 4040* (JRAU)
calycinum Benth.	*Moteetee 10* (JRAU); *Schutte 349** (JRAU); *Thorne 54470* (SAM)
candicans Eckl. & Zeyh.	*Rourke 1739* (PRE); *Schutte 499* (JRAU); *Schutte 252* (JRAU)
canescens Benth.	*Dean 648* (JRAU); *De Castro 126** (JRAU); *Van Wyk 3058** (JRAU)
exudans Harv.	*Van Wyk 2468, 2692, 2702** (JRAU)
humile Eckl. & Zeyh.	*Powrie 648* (PRE); *Van Wyk 2351, 2543** (JRAU)
lampolobum (E.Mey.) A.Moteetee & B.-E.van Wyk	*Marshall 234* (JRAU); *Van Wyk 2143* (JRAU); *M. van Wyk 1081** (PRE)
macrocalyx Dummer	*Basson 105** (PRE); *Moteetee 8* (JRAU); *Van Wyk 3061* (JRAU)
microphyllum (L.f.) Eckl. & Zeyh.	*Bredenkamp 1121* (PRE); *Bolus 37* (BOL); *De Winter 2601* (NBG); *Moteetee & Van Wyk 3* (JRAU)
obcordatum Harv.	*Moteetee & Van Wyk 4* (JRAU); *Schutte 147*, 394** (JRAU)
stipulatum Harv.	*Van Wyk 2239, 2562*, 4037* (JRAU)
subspicatum Conrath	*Moteetee & Van Wyk 2* (JRAU); *Schutte 108** (JRAU); *Van Wyk 1779* (JRAU)
wilmsii Harms	*Moteetee & Van Wyk 1* (JRAU), *Schutte 402*, Van Wyk 2624** (JRAU)
Adenocarpus	
mannii Hook.f.	*Teixeira & Andrade 4665* (PRE)
Argyrolobium	
frutescens Burtt Davy	*Van Wyk 1858, 2815** (JRAU)
lanceolatum Eckl. & Zeyh.	*Schutte 469**; *Van Wyk 2080, 2087* (JRAU)
megarrhizum Bolus	*Van Wyk 2923, 3611* (JRAU)
Dichilus	
gracilis Eckl. & Zeyh.	*Schutte 227, 241* (JRAU); *M. van Wyk 2501** (JRAU)
*lebeckioides** DC.	*De Castro 128* (JRAU); *Schutte 118* (JRAU); *Van Wyk 1538* (JRAU)
*pilosus** Conrath ex Schinz	*De Castro 115 (JRAU)*; *Schutte 95, 127* (JRAU)
*reflexus** (N.E.Br.) A.L.Schutte	*Schutte 183, 188* (JRAU); *Stirton 11795* (JRAU)
strictus E.Mey.	*Schutte 150*, 155* (JRAU); *Van Wyk 1553* (JRAU)
Polhillia	
*brevicalyx** (C.H.Stirt.) B.-E.van Wyk & A.L.Schutte	*Schutte 388* (JRAU); *Van Wyk 2104, 2134* (JRAU)
canescens C.H.Stirt.	*Van Wyk 2094, 2092* (JRAU)
*involucrata** (Thunb.) B.-E.van Wyk & A.L.Schutte	*Schutte 398* (JRAU); *M. Steenkamp sub Schutte 379* (JRAU)
*obsoleta** (Harv.) B.-E.van Wyk	*Van Wyk 214, 2701* (JRAU)
pallens C.H.Stirt.	*Van Wyk 2095, 2129*, 2708* (JRAU)

* Species and specimens used only for SEM studies.

however, some hairs have one basal cell, whereas others have two. In the latter case, the basal cell appears to have divided periclinally (Figure 1B). The basal cells are structurally similar to other epidermal cells and the stalk cell is very thick-walled (Figure 1B). In *Argyrolobium*, *Dichilus* and *Polhillia* on the other hand, there is always one basal cell, which like the other epidermal cells, is papillate (Figure 1C). In this case the stalk cell is also markedly thickened. According to Solereder (1908) the terminal cell is often uniformly or spirally thickened, with verrucose or peg-shaped irregularities on the surface. Scanning electron microscopy shows that in the examined species there are two types of surface sculpturing of the terminal cell: striated and verrucose. In all species of *Melolobium*, hairs have striated surfaces (Figure 4A), whereas in all species of *Dichilus* they are verrucose (Figure 4B). In *Argyrolobium* and *Polhillia*, both striated and verrucose hairs are present (Schutte 1988).

Stalked glands and sessile glands occur only in *Melolobium* species and not in any of the other genera. Structural details of these two types of glands are recorded and illustrated for the first time. Stalked glands have a spherical, unicellular head and a multicellular stalk consisting of several elongated cells (Figure 2A–D). According to Solereder (1908), the glands in *Melolobium* are unicellular and consist of a short globular head. Polhill (1976) likened them to those found in *Adenocarpus*, but Solereder (1908) described the glands of *Adenocarpus* as 'multicellular glandular shaggy hairs, columnar in shape and broadened in a capitate manner at their apex'. Gibbs (1967) referred to *Adenocarpus* glands as glandular papillae arising 'as outgrowths of columnar-shaped epidermal cells'. Examination of these glands, however, shows that they are neither shaggy hairs nor papillae, but rather multicellular glands (Figure 2E) with broad capitate apices unlike the unicellular-headed and narrow-stalked glands of *Melolobium*.

Sessile glands (Figure 3) are not visible to the naked eye and are barely visible under the dissecting microscope. Some species such as *M. alpinum* Eckl. & Zeyh. and *M. candicans* (E.Mey.) Eckl. & Zeyh. have previously been described as non-glandular (Harvey 1862), possibly because these minute glands were not detected. Stalked glands and sessile glands never co-occur, but may be found on different parts of the same plant. For example, two species with sessile glands on their leaves, *M. exudans* and *M. stipulatum* Harv., also have stalked ones on their calyces and pods.

TABLE 2.—Epidermal features of *Argyrolobium, Dichilus, Melolobium* and *Polhillia*

Taxon	Distribution of glands: Leaf, abaxial surface	Distribution of glands: Leaf, adaxial surface	Distribution of glands: Calyx	Distribution of glands: Stem	Distribution of hairs: Leaf, margin	Distribution of hairs: Leaf, abaxial midrib	Distribution of hairs: Leaf, abaxial entire	Distribution of hairs: Leaf, adaxial midrib	Distribution of hairs: Leaf, adaxial entire	Distribution of hairs: Calyx	Hair surface sculpturing
Melolobium											
adenodes	G	G	G	G	R	R	R	-	-	+	V
aethiopicum	-	-	-	-	+	+	+	+	+	+	V
alpinum	-	S	S	S	+	+	+	R	R	+	V
calycinum	-	-	-	-	+	+	+	+	+	+	V
candicans											
typical form	-	S	S	S	R	+	+	R	R	+	V
Kamiesberg form	-	S	S	S	R	+	-	-	-	+	V
Richmond form	-	S	S	S	R	+	R	-	-	+	V
Sutherland form	-	S	S	S	+	+	R	-	-	+	V
glandular form	-	S	G	S	+	+	+	+	+	+	V
canescens											
typical form	-	S	S	S	+	+	+	+	+	+	V
Northern Cape form	-	S	S	S	-	+	-	-	-	+	V
glandular form	-	S	G	S	+	+	+	+	+	+	V
exudans											
typical form	S	S	G	S	-	-	-	-	-	+	V
Hex River form	S	S	G	S	-	-	-	-	-	+	V
Verkeerdevlei form	S	S	G	S	-	-	-	-	-	+	V
humile											
typical form	G	G	G	G	+	+	+	+	+	+	V
Malmesbury form	G	G	G	G	R	+	R	-	R	+	V
lampolobum	-	-	S	-	-	-	-	-	-	R	V
macrocalyx											
var. *macrocalyx*											
typical form	-	-	-	-	+	+	+	+	+	+	V
northern form	-	-	-	-	+	+	R	R	R	+	V
var. *longifolium*	-	-	-	-	+	+	+	+	+	+	V
microphyllum											
typical form	G	G	G	G	+	+	+	+	+	+	V
Fauresmith form	G	G	G	G	+	R	R	-	-	+	V
southern form	G	G	G	G	-	R	-	-	-	+	V
Eastern Cape form	G	G	G	G	R	R	+	+	+	+	V
Windhoek form	G	G	G	G	+	+	+	+	+	+	V
obcordatum	G	G	G	G	+	+	+	+	+	+	V
stipulatum	-	S	G	S	+	+	+	+	+	+	V
subspicatum	-	-	S	-	+	+	+	-	-	+	V
wilmsii	-	-	S	-	+	+	R	-	-	+	V
Argyrolobium											
frutescens	-	-	-	-	+	+	+	+	+	+	St
lanceolatum	-	-	-	-	+	+	+	+	+	+	St
megarrhizum	-	-	-	-	+	+	+	R	R	+	St
Dichilus											
gracilis	-	-	-	-	+	+	+	-	-	+	St
lebeckioides	-	-	-	-	+	+	+	-	-	+	St
pilosus	-	-	-	-	+	+	+	-	-	+	St
reflexus	-	-	-	-	+	+	+	-	-	+	St
strictus	-	-	-	-	+	+	+	-	-	+	St
Polhillia											
brevicalyx	-	-	-	-	+	+	+	+	+	+	St
canescens	-	-	-	-	+	+	+	+	+	+	V
involucrata	-	-	-	-	-	-	-	-	-	+	V
obsoleta	-	-	-	-	+	+	+	+	+	+	St
pallens	-	-	-	-	+	+	+	+	+	+	V

G, stalked glands; S, sessile glands; + present; - absent; R, rare; V, verrucose; St, striated.

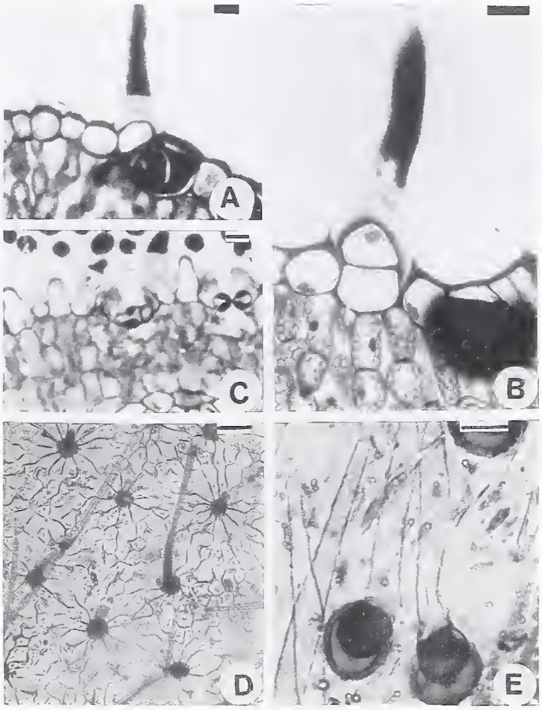

FIGURE 1.—LM photographs of uniseriate hairs: A, *Melolobium aethiopicum*, *Van Wyk 4036*, l/s with one basal cell; B, *M. calycinum*, *Moteetee 10*, l/s with two basal cells; C, *Argyrolobium megarrhizum* Bolus, *Van Wyk 3611*, l/s with papillate basal cells; D, *M. aethiopicum*, *Van Wyk 4040*, surface view, with some of terminal cells broken off; E, *M. microphyllum*, *Moteetee & Van Wyk 3*, surface view. Scale bars: 10 µm.

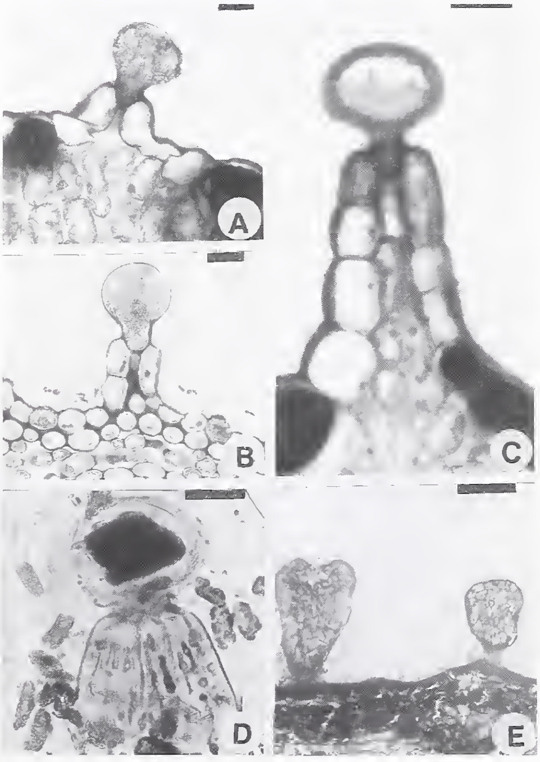

FIGURE 2.—LM photographs of stalked glands: A, *Melolobium adenodes*, *Van Wyk 3070*, l/s; B, *M. obcordatum*, *Moteetee & Van Wyk 4*, l/s. C, D, *M. adenodes*, *Van Wyk 4036*: C, l/s; D, surface view. E, *Adenocarpus mannii* Hook.f., *Teixeira & Andrade 4665*, l/s multicellular glands. Scale bars: A–D, 25 µm; E, 75 µm.

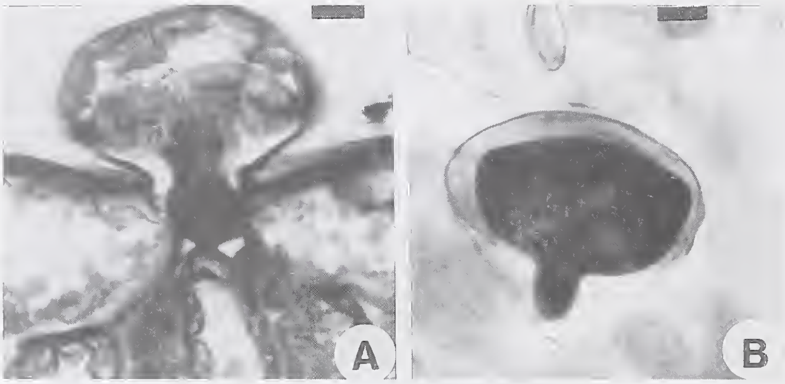

FIGURE 3.—LM photographs of l/s of sessile glands: A, *Melolobium alpinum*, *Schutte 332*; B, glandular form of *M. candicans*, *Schutte 499*. Scale bars: A, B, 5 µm.

The co-occurrence of structures is generally indicative of non-homology. Since stalked and sessile glands never co-occur in *Melolobium*, a sessile gland may be a stalked gland in which development was merely arrested at the unicellular stage. Sessile and stalked glands have diagnostically different distributions at the species level with no variation at all within species. Hairs, on the other hand, are more variable in distribution and can be used to distinguish between different populations within some of the species.

The function of glandular trichomes in *Melolobium* is not yet clear, but many species are viscid. Examination of epidermal peels of the leaves revealed the heads of the glands to have dense protoplasts (Figures 2A, B, D; 3), further suggesting that these structures might be secretory in nature. In *Adenocarpus*, 'the inner cells of the glands break down at maturity to produce a viscous secretion' (Gibbs 1967). Glandular trichomes are known to secrete a large number of different substances, including water, salt, nectar, mucilage, terpenes and digestive enzymes (Esau 1977). Studies are being carried out to determine the chemical nature of the contents of these glands.

Hair distribution

In *Melolobium* the distribution of hairs on the leaflet blade varies greatly, even within a species, but is highly consistent within various forms or provenances. For example, in the 'typical' form of *M. humile* Eckl. & Zeyh., hairs occur on all parts of the lamina, whereas in the 'Malmesbury' form they occur only on the adaxial midrib and are rare or absent on other parts. Hairs are most commonly present on the leaflet margins and abaxial midrib, with the exception of *M. adenodes* Eckl. & Zeyh. and some forms of *M. microphyllum* (L.f.) Eckl. & Zeyh. where they are absent. In general, hairs are less frequent on the adaxial surface than on the abaxial one. Hairs can be used to distinguish many of the species of *Melolobium*. *M. adenodes* is allied to *M. humile* (both glandular), for example, but the former is subglabrous and the latter is densely hairy. *M. aethiopicum* (L.) Druce superficially resembles *M. alpinum*, but leaves of the former are hairy on both surfaces, whereas the latter is only sparsely hairy on the upper surface. In all species of *Melolobium*, glands (whether stalked or sessile) and hairs co-occur. The distribution of hairs is not correlated with the type of glands.

CONCLUSIONS

The type and distribution of glands is of diagnostic significance at the generic level in African Genisteae and at the species level within *Melolobium*. The type and distribution of hairs is of taxonomic value at both species and population (provenance) levels. Within the Genisteae, the microscopic structure of hairs and glands is unique in *Melolobium*. The glands in *Melolobium* and *Adenocarpus* are not homologous.

Key to species of *Melolobium* based on trichome type and distribution

1a Stalked glands present:
 2a Stalked glands on calyces only:
  3a Plants unarmed:
   4a Plants hairy . . . . *M. stipulatum*
   4b Plants almost glabrous . . . . *M. exudans*

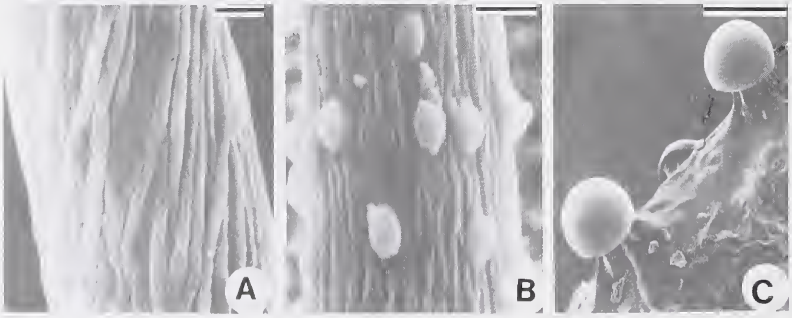

FIGURE 4.—SEM micrographs: A, striated hair surface in *Melolobium calycinum*, *Thorne 54470*; B, verrucose hair surface in *Dichilus gracilis* Eckl. & Zeyh., *Schutte 241*; C, *M. humile*, *Van Wyk 2351*, stalked glands. Scale bars: A, B, 2 µm; C, 100 µm.

3b Plants spiny:
5a Pods straight . . . . *M. candicans**
5b Pods falcate . . . .*M. canescens** (E.Mey.) Benth.
2b Stalked glands on stems, leaves and calyces:
6a Plants glabrous or subglabrous . . . . *M. adenodes*
6b Plants sparsely to densely hairy:
7a Plants unarmed or slightly spinescent:
8a Leaflets distinctly obcordate, apex sharply emarginate; bracts obliquely lanceolate to ovate . . . .*M. obcordatum* Harv.
8b Leaflets obovate-oblong, apex mucronate; bracts cordate to suborbicular . . . . *M. humile*
7b Plants distinctly spiny . . . . *M. microphyllum*
1b Stalked glands absent:
9a Sessile glands present, at least on calyces (visible under 20 × magnification):
10a Plants distinctly spiny:
11a Stems and pods subglabrous, the latter distinctly shiny . . . . *M. lampolobum*
11b Stems and pods usually densely hairy, velutinous:
12a Pods straight . . . . *M. candicans*
12b Pods falcate . . . . *M. canescens*
10b Plants unarmed:
13a Sessile glands on leaves and calyces . . . . *M. alpinum*
13b Sessile glands on calyces only:
14a Stipules present . . . . *M. wilmsii* Harms.
14b Stipules absent . . . . *M. subspicatum* Conrath
9b Sessile glands absent:
15a Plants distinctly spiny . . . . *M. calycinum* Benth.
15b Plants unarmed:
16a Leaves and calyces densely silky; pods short, scarcely exceeding calyx . . . . *M. macrocalyx* Dummer
16b Leaves and calyces pubescent; pods several times longer than calyx . . . . *M. aethiopicum*

* Some forms of *M. candicans* and *M. canescens* are glandular as in *M. microphyllum*. Since there is no strong geographical pattern in the distribution of glandular forms of *M. candicans* and *M. canescens*, we suspect there is hybridization/ introgression between *M. microphyllum* and these two species

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Pollen morphology and biometry of the genus *Androcymbium* (Colchicaceae) in southern Africa: taxonomic and biogeographic considerations

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Keywords: *Androcymbium* Willd., biogeography, Colchicaceae, pollen biometry, pollen morphology, southern Africa, taxonomy

ABSTRACT

Pollen characters in 16 southern African type specimens of *Androcymbium* Willd. that represent the three sections into which the genus is presently divided (*Androcymbium*, *Dregeocymbium* and *Erythrostictus*), were examined to assess the possibility of sectional characterization based on pollen traits and to explore the relationship between pollen traits and geographic species distribution. Differences in pollen grain size, shape, number of apertures and exine pattern, were observed. Principal Component Analysis, using both qualitative and biometric pollen characters, distinguished four groups of species with four different pollen types. Most of the species have a microreticulate exine pattern with either diaperturate or triaperturate grains. The remaining species have either a rugulate exine pattern with diaperturate grains, or a rugulate-reticulate exine pattern with thickened (hypertrophied) muri with diaperturate grains. While section *Dregeocymbium* can be well delimited by the unique thickened muri, and by a significantly larger grain size, no diagnostic pollen traits were found for sections *Androcymbium* and *Erythrostictus*. Similarly, although the six northern African species exhibit a microreticulate exine pattern, the high variability observed for this trait in their southern African counterparts, does not follow a geographic pattern.

INTRODUCTION

The genus *Androcymbium* Willd. (Colchicaceae) comprises ± 50 species (Müller-Doblies & Müller-Doblies 1984, 1990, 1998; Arnold & De Wet 1993; Pedrola-Monfort *et al.* 1999a, b, in press) whose distribution (Figure 1) embraces arid areas in western southern Africa (with about 35 species), eastern southern Africa (with six species), northern southern Africa and eastern Africa (with two species), the Mediterranean area (with four species) and the Canary Islands (with two species). *Androcymbium* is the only member of the tribe Colchiceae together with *Colchicum* L. *sensu lato* (i.e. including *Bulbocodium* L., *Merendera* Ram. and *Synsiphon* Regel). At present, the genus is divided into three sections based on tepal blade morphology (Krause 1921): section *Androcymbium*, characterized by green, curved, winged tepal blades, with representatives throughout southern Africa; section *Dregeocymbium*, possessing flat, unwinged tepals and very short stamens and styles, with representatives in western southern Africa; and section *Erythrostictus*, featuring white, flat, unwinged tepal blades, with representatives in southern Africa, the Mediterranean area and the Canary Islands. However, these differential morphological traits are currently considered irrelevant (Müller-Doblies & Müller-Doblies 1990, 1998; Pedrola-Monfort 1993) and, consequently, of little taxonomic value. A previous taxonomic study based on pollen morphological characters of 11 *Androcymbium* species representing the sections *Erythrostictus* and *Androcymbium* (Martín *et al.* 1993),

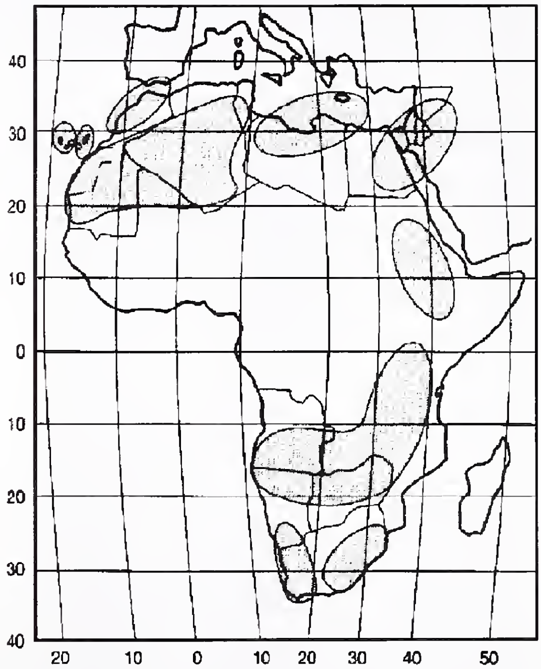

FIGURE 1.—Distribution of the genus *Androcymbium*.

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TABLE 1.—Herbarium specimens of *Androcymbium* studied in South Africa. Abbreviations of the herbariums follow Holmgren *et al.* (1990)

Species	Province	Collector and herbarium
Section *Androcymbium*		
albomarginatum Schinz (holo. *A. schlechteri* K.Krause)	NC	*Schlechter 11081* (B)
burchellii Baker subsp. *pulchrum* (Baker) Pedrola, Membrives, J.M.Monts. & Caujapé (holo. *A. pulchrum* Schltr. & K.Krause)	NC	*Schlechter 10953* (B)
ciliolatum Schltr. & K.Krause	WC	*Schlechter 8409* (B)
circinatum Baker (iso. *A. guttatum* Schltr. & K.Krause)	NC	*Schlechter 11280* (B)
crispum Schinz (holo. *A. pritzelianum* Diels)	NC	*Diels 701* (MO)
decipiens N.E.Br.	KZN	*Rich 5764* (NH)
hantamense Engl.	NC	*Meyer 1869* (B)
henssenianum U.Müll.-Doblies & D.Müll.-Doblies	NC	*U. & D. Müller-Doblies 79177a* (B)
irroratum Schltr. & K.Krause	WC	*Schlechter 8016* (B)
natalense Baker	KZN	*Movd 200* (NH)
scabromarginatum Schltr. & K.Krause	NC	*Schlechter 11188* (B)
villosum U.Müll.-Doblies & D.Müll.-Doblies	NC	*U. & D. Müller-Doblies 80081j* (B)
volutare Burch.	NC	*Hanekon 2413* (K)
Section *Dregeocymbium*		
dregei C.Presl	NC	*Baker 2705* (B)
exiguum Roessler subsp. *vogelii* U.Müll.-Doblies & D.Müll.-Doblies	NC	*U. & D. Müller-Doblies 79173a* (B)
Section *Erythrostictus*		
cruciatum U.Müll.-Doblies & D.Müll.-Doblies	NC	*U. & D. Müller-Doblies 80099n* (B)

KZN, KwaZulu-Natal; NC, Northern Cape; WC, Western Cape.

TABLE 2.—Morphological and biometrical pollen characters of *Androcymbium* species. Values correspond to the mean ± standard deviations. Numbers in parenthesis are the minimum and maximum values of each parameter

Species	P	E1	E2	P/E1 ratio	Ap	Exine pattern
albomarginatum	9.97±1.38 (7.00-13.44)	14.98±1.88 (11.59-18.23)	11.08±1.44 (8.51-13.56)	0.67	3	MR
burchellii subsp. *pulchrum*	10.19±1.37 (8.20-13.35)	17.88±1.80 (12.82-20.30)	12.53±2.02 (7.58-15.72)	0.57	2	MR
ciliolatum	9.69±3.24 (5.02-14.10)	16.14±3.51 (10.43-22.76)	11.52±0.70 (10.78-13.39)	0.59	3	MR
circinatum	10.97±1.28 (8.34-12.82)	16.95±1.86 (14.88-21.15)	10.39±1.07 (8.84-12.11)	0.65	3	MR
crispum	10.42±1.31 (7.98-12.35)	17.00±2.20 (13.82-21.12)	12.73±1.78 (9.51-15.15)	0.62	2	MR
cruciatum	10.16±2.50 (6.89-14.25)	20.13±2.38 (14.91-24.77)	11.69±0.80 (9.99-12.93)	0.50	2	MR
decipiens	19.13±2.76 (15.92-23.23)	26.06±3.44 (18.90-32.07)	18.90±2.21 (16.07-22.28)	0.74	2	R
dregei	22.58±2.17 (18.63-26.67)	31.20±3.28 (23.37-35.36)	23.03±0.0 (23.03)	0.73	2	RA
exiguum subsp. *vogelii*	29.61±2.01 (25.84-36.86)	37.14±0.85 (35.54-39.78)	35.23±3.14 (24.34-42.97)	0.79	2	RA
hantamense	13.51±0.79 (11.56-15.88)	18.99±1.02 (15.93-22.67)	17.62±1.42 (11.27-20.01)	0.71	3	MR
henssenianum	19.16±5.00 (12.75-27.49)	25.66±3.97 (19.30-30.71)	18.02±3.39 (12.85-23.56)	0.74	2	R
irroratum	10.62±1.87 (7.37-13.34)	18.80±2.58 (13.83-24.68)	12.59±3.17 (7.63-18.38)	0.57	3	MR
natalense	17.83±2.18 (15.37-22.80)	24.96±4.30 (15.67-34.28)	18.84±2.87 (13.76-23.83)	0.73	2	R
scabromarginatum	10.04±3.13 (5.76-16.57)	14.65±2.82 (9.34-20.91)	9.70±1.80 (7.94-15.37)	0.69	3	MR
villosum	9.12±1.64 (4.12-11.63)	14.87±1.73 (12.66-20.55)	9.85±1.12 (7.59-11.43)	0.62	3	MR
volutare	8.60±1.31 (6.01-11.16)	14.43±1.93 (11.66-19.51)	8.93±0.80 (7.21-10.10)	0.60	2	MR

Ap, no. apertures; E1, equatorial long axis; E2, equatorial short axis; MR, microreticulate; P, polar axis; R, rugulate; RA, rugulate-reticulate with thickened (hypertrophied) muri.

offered four important insights. Firstly, there is no single pollen character that separates the two sections. Secondly, a microreticulate exine pattern was observed in all but the Canary Island species, *A. psammophilum* Svent., which has a rugulate exine pattern. Thirdly, whereas the pollen in section *Erythrostictus* is always diaperturate, both di- and triaperturate forms co-exist within section *Androcymbium*. And lastly, the pollen size of the western southern African *A. bellum*, that was historically ascribed to section *Erythrostictus*, fits the range of values observed for the species in section *Androcymbium*.

Given the variability in pollen traits noted in that survey, we undertook the analysis of all the measurable pollen characters, the number of apertures and the exine patterning in a broader geographic representation of the genus. The aims of this study are to assess whether there might be traits of diagnostic value for the three sections of the genus currently recognized and to examine the relationship between pollen morphology and geographic distribution.

MATERIAL AND METHODS

Sixteen type specimens of *Androcymbium* were examined (Table 1), representing southern African species housed in the Museum Botanicum Berolinense (B), Royal Botanic Gardens, Kew (K), and Natal Herbarium (NH).

Pollen was extracted from the anthers with a drop of alcohol (96%) and then acetolysed according to the Avetissian micromethod (Avetissian 1950). For the biometric study, pollen grains were mounted in glycerol jelly and measured with the image analyser IMAT at the facilities of the Serveis Científico-Tècnics of Barcelona University.

The four biometric characters used (Table 2), follow Erdtman (1969) and Reitsma (1970). The arithmetical mean, standard deviation, and maximum and minimum values were calculated after 15 measurements for each parameter (Table 2) using the SPSS/PC+ program (SPSS 1984). Exine patterning and the number of apertures were determined with the aid of a scanning electron microscope (SEM). The pollen was first mounted onto SEM stubs and then coated with gold in a diode sputter-coater. The stubs were observed using a Hitachi 52300 electron microscope at 15 kv at the facilities of the Serveis Científico-Tècnics of Barcelona University.

A test of comparison of means was conducted using the program SPSS/PC+ (SPSS 1984) to assess the possible relationship between the pollen parameters considered. Principal component analysis (PCA) was conducted using the program NTSYS-PC (Rohlf 1992) to visualize the relationships among the studied species based on pollen data. For this multivariate analysis, four continuous quantitative characters (P, E1, E2 and P/E1 ratio), one discrete quantitative character (aperture number) and one qualitative character (exine patterning) were included. The latter was coded as: 1 = microreticulate, 2 = rugulate, or 3 = rugulate-reticulate with thickened (hypertrophied) muri. We used the arithmetical mean values of quantitative characters across species to build a 6×16 data matrix that was standardized and used to calculate the correlation matrix after which the principal components were derived.

RESULTS

General morphology: the pollen of *Androcymbium* is heteropolar, planoconvex in equatorial view and elliptic in polar view, with bilateral symmetry. This pollen morphology is typical of the Colchicaceae (Erdtman 1952, 1969; Díez 1987; Díez *et al.* 1985; Martín *et al.* 1993). The values of P, E1, E2 and P/E1 ratio are summarized in Table 2. The smallest pollen is produced by *A. volutare*, $8.60 \times 14.43 \times 8.93$ µm, and the largest by *A. exiguum* subsp. *vogelii*, $29.61 \times 37.14 \times 35.23$ µm. The pollen grains of the *Androcymbium* species examined are considerably smaller than those of the closely related genera *Colchicum* L. and *Merendera* Ram. (Erdtman 1952, 1969; Faegri & Iversen 1975; Díez 1987; Díez *et al.* 1985).

Among the species studied, the most frequent pollen shape is oblate ($0.5 < P/E1 < 0.69$) and found in *A. albomarginatum*, *A. burchellii* subsp. *pulchrum*, *A. ciliolatum*, *A. circinatum*, *A. crispum*, *A. irroratum*, *A. scabromarginatum*, *A. villosum*, and *A. volutare*. However, the grains of *A. cruciatum* tended to be peroblate (P/E1 = 0.5), and those of *A. dregei*, *A. decipiens*, *A. hantamense*, *A. henssenianum*, *A. natalense*, and *A. exiguum* subsp. *vogelii* are suboblate ($0.70 < P/E1 < 0.79$).

Apertural system: *Androcymbium's* pollen apertures are circular or elliptic pores. Seven of the species examined (Table 2) are two-zonoporate, anaporate with two pores either in zonal or in presumed equatorial position and the third in distal position (Figure 2A). The remaining nine species are two-zonoporate (two pores in zonal position, Figure 2C, E, G). We have not studied the tetrad of pollen grains in *Androcymbium*, but the position of the pollen grains in the tetrad was well studied in the closely related genus *Colchicum* (Béguin & Huynh 1978).

Exine patterning: three different exine patterns were observed among the species of *Androcymbium* analysed: 1, microreticulate (Figure 2A–D; Table 2), with the lumina less than 1 µm diameter, observed in *A. albomarginatum*, *A. burchellii* subsp. *pulchrum*, *A. ciliolatum*, *A. circinatum*, *A. crispum*, *A. cruciatum*, *A. hantamense*, *A. irroratum*, *A. scabromarginatum*, *A. villosum*, and *A. volutare*; 2, rugulate (Figure 2E, F), observed in *A. decipiens*, *A. henssenianum*, and *A. natalense;* and 3, rugulate-reticulate with thickened (hypertrophied) muri (Figure 2G, H) and lumina's diameter higher than 1 µm, observed in *A. dregei* and *A. exiguum* subsp. *vogelii*. Pollen terminology follows Blackmore *et al.* (1992).

Comparison of means: the ANOVA test revealed significant differences among species only in terms of the number of pores and pollen grain size, with diaperturate pollen tending to be larger than triaperturate pollen. Furthermore, there are significant differences in the values of P, E1, E2 and P/E1 ratio for the exine patterning,

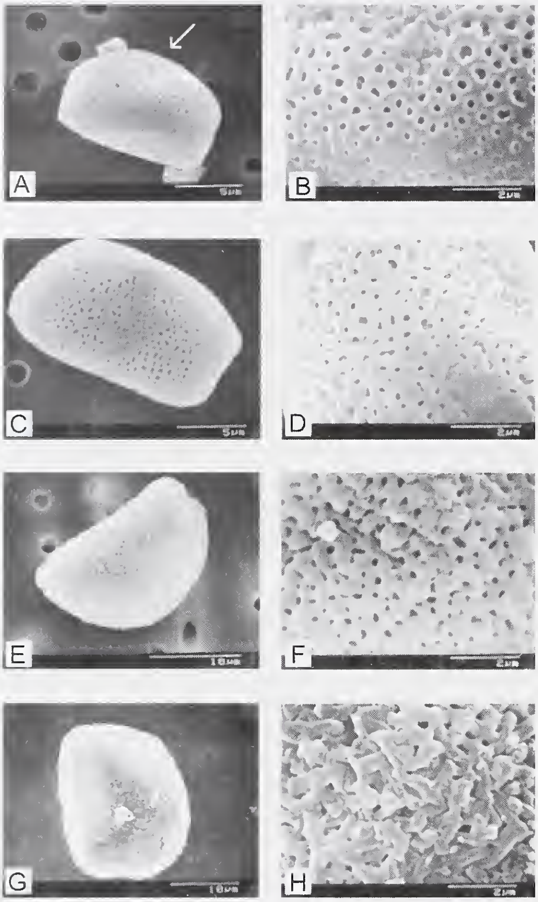

FIGURE 2.—Scanning electron micrographs showing the four pollen types of *Androcymbium* observed. A, B, *A. scabromarginatum*, Type 1: triaperturate microreticulate, arrow points to third aperture. C, D, *A. cruciatum*, Type 2: diaperturate microreticulate. E, F, *A. hensseniannm*, Type 3: diaperturate rugulate. G, H, *A. exiguum* subsp. *vogelii*, Type 4: diaperturate rugulate-reticulate with thickened (hypertrophied) muri.

TABLE 3.—Values of first and second principal components from multivariate analysis of pollen characters studied

Character	Principal component	
	First	Second
P	0.994	0.076
E1	0.978	-0.067
E2	0.958	0.080
Exine pattern	0.971	-0.011
P/E1 ratio	0.785	0.476
No. apertures	-0.571	0.787

E1, equatorial long axis; E2, equatorial short axis; P, polar axis

with rugulate and rugulate-reticulate grains with thickened (hypertrophied) muri, larger than microreticulate pollen grains.

Principal component analysis: the first and second principal components (Table 3) explain 93.5% of the variance of the sample, 79.1% for the first component—Factor 1; and 14.4% for the second—Factor 2. Whereas the former is mainly determined by the biometric characters and the exine pattern (P, E1, exine patterning, E2 and P/E ratio, in order of importance), the latter is most influenced by the number of apertures. The relationships among species according to this analysis are represented in a two-dimensional graph (Figure 3).

The results of the PCA indicate four groups of species with different pollen types:

Type 1: triaperturate (two-zonoporate anaporate), microreticulate (Figure 2A, B), found in *A. albomarginatum, A. ciliolatum, A. circinatum, A. hantamense, A. irroratum, A. scabromarginatum,* and *A. villosum* (section *Androcymbium*);

Type 2: diaperturate (two-zonoporate), microreticulate (Figure 2C, D), observed in *A. crispum, A. burchellii* subsp. *pulchrum* and *A. volutare* (section *Androcymbium*) and in *A. cruciatum* (section *Erythrostictus*);

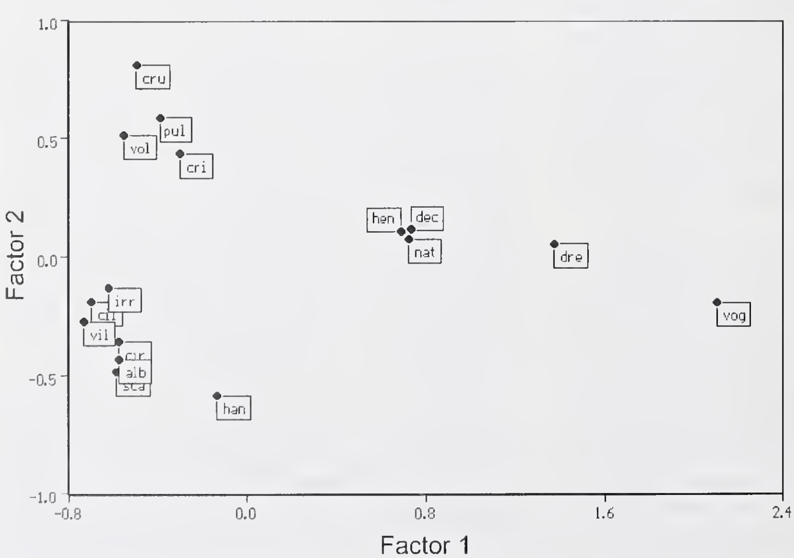

FIGURE 3.—Two-dimensional graph representing species in the PCA. Variance of sample is 93.5 % (79.1 % for factor 1, and 14.4 % for factor 2). Names of spp. abbreviated with first three letters of epithet. Distribution of spp. indicates four pollen types. Type 1: in left lower part, *A. albomarginatum, A. ciliolatum, A. circinatum, A. hantamense, A. irroratum, A. scabromarginatum, A. villosum*. Type 2: in left upper part: *A. crispum, A. burchellii* subsp. *pulchrum, A. volutare, A. cruciatum*. Type 3: central : *A. decipiens, A. hensseniannm, A. natalense*. Type 4: on right, *A. dregei, A. exiguum* subsp. *vogelii*.

Type 3: diaperturate (two-zonoporate) rugulate (Figure 2E, F), observed in *A. decipiens, A. henssenianum,* and *A. natalense* (section *Androcymbium*);

Type 4: diaperturate (two-zonoporate), rugulate-reticulate with thickened (hypertrophied) muri (Figure 2G, H), found in *A. dregei* and *A. exiguum* subsp. *vogelii* (section *Dregeocymbium*).

DISCUSSION

Taxonomic implications

According to our results, the southern African species of *Androcymbium* contain most of the diversity of pollen types described for the entire genus (Figure 2). The most common exine patterning observed in this geographical region is microreticulate (Figure 2A–D) and was found both in species from section *Androcymbium* and in section *Erythrostictus* (*A. cruciatum* in Müller-Doblies & Müller-Doblies 1984). Although all the species with triaperturate pollen (Type 1) are in section *Androcymbium,* this fact is of very limited taxonomic value, since roughly half of the species within this section exhibit diaperturate pollen (Types 2 and 3) and pollen Type 2 was also observed in most of the North African *Androcymbium* species (section *Erythrostictus*) by Martín *et al.* (1993).

The diversity of pollen shape notwithstanding, two additional facts hinder an unambiguous sectional characterization in the genus *Androcymbium.* Firstly, the pollen of the taxa within section *Androcymbium* (*A. burchellii* subsp. *pulchrum, A. crispum* and *A. volutare*) is indistinguishable from that of *A. cruciatum,* which belongs to section *Erythrostictus.* Secondly, the rugulate exine patterning (Type 3; Figure 2E, F) observed in *A. decipiens, A. hensseniamum* and *A. natalense* (section *Androcymbium*) was also found in the Canary Island *A. psammophilum,* which belongs to section *Erythrostictus* (Martín *et al.* 1993). However, the relevance of the latter observation is only minor because, unlike *A. decipiens, A. hensseniamum,* and *A. natalense*, the structural elements of *A. psammophilum* are always less than 1 μm in diameter and might be considered as a different pollen pattern.

By contrast, the pollen of the constituents of section *Dregeocymbium, A. dregei* and *A. exiguum* subsp. *vogelii,* can be unambiguously characterized in terms of two traits: a significantly larger grain size and a rugulate exine pattern (Type 4, Figure 2G, H).

Section *Androcymbium* embraces a diverse array of pollen types, including either microreticulate or rugulate exine patterning, and di- or triaperturate pollen grains. Species from section *Erythrostictus* have microreticulate exine patterning and diaperturate pollen grains, and share these features with some of the species of section *Androcymbium.*

Biogeographic and evolutionary implications

A microreticulate exine pattern is a general feature of species in the families Liliaceae and Colchicaceae (Erdtman 1952, 1969; Valdés 1978; Díez 1987; Díez *et al.* 1985) and is considered to be the plesiomorphic condition for the Liliales (Goldblatt 1990; Goldblatt & Henrich 1991). Although the species of *Androcymbium* that have a microreticulate exine pattern (Type 1 and 2) occur in two of the three broad areas of distribution of the genus (western southern Africa and North Africa), we cannot assert that this feature is represented in all areas of distribution until the study of some species from eastern southern Africa (mainly those within the *Androcymbium melanthioides* complex) is completed.

By contrast, rugulate forms (Type 3) are considered evolutionarily recent and have been observed both in western southern African (*A. hensseniamum*) and eastern southern African species (*A. decipiens* and *A. natalense*). Rugulate-reticulate exine pattern with thickened (hypertrophied) muri can also be considered evolutionarily recent and is present only in the western southern African species *A. dregei* and *A. exiguum* subsp. *vogelii* (section *Dregeocymbium*). Thus, available evidence indicates that more recent exine pattern types are exclusive to southern African species, whereas plesiomorphic forms occur both in this region and in northern Africa. However, our survey failed to detect a geographic pattern in the genus, because southern African species exhibit a high variability of exine patterning.

The pollen of the tribe Colchiceae is generally characterized by two, three or four apertures (Erdtman 1952, 1969; Díez 1987; Díez *et al.* 1985), although four apertures have been reported much less frequently (Dahlgren *et al.* 1985). Where the pollen grains are triaperturate, the two equatorially positioned apertures are pores, whereas the third one, situated at the distal pole, is an ulcus (Erdtman 1952, 1969). The dichotomy observed in terms of number of apertures in *Androcymbium* has evolutionary implications. As a rule, the monosulcate aperture is considered the most primitive in the monocotyledons (Nair 1970; Goldblatt 1990; Goldblatt *et al.* 1991). Some authors argue that the porate apertural system derives from a reduction of the aperture zone, and the triaperturate form represents a transition from monosulcate to two-zonoporate (Thanikaimoni 1986; Takhtajan 1991). Given that species of *Androcymbium* having triaperturate pollen occur only in western southern Africa, our data support the hypothesis that this area might be the ancestral area of distribution of the genus (Margelí *et al.* 1999; Caujapé-Castells *et al.* 1999, 2001). However, this conclusion must be complemented with the pollen morphological survey of the species of *Androcymbium* distributed in eastern southern Africa that could not be included in this work.

CONCLUSIONS

Although our results suggest a general trend towards parallel evolution of pollen size and structural complexity of exine pattern in *Androcymbium,* they do not indicate a relationship between pollen morphology and geographic distribution. Species with pollen Type 2 (microreticulate exine pattern with diaperturate apertural system) are ubiquitous and occur throughout the range of the genus. The presence of the third aperture in the distal

position in triaperturate pollen, which has been considered by previous authors to be more primitive than the diaperturate condition, was observed only in western southern African species of *Androcymbium*. Pending the survey of some of the eastern southern African species that could not be included in this work, this result enforces the hypothesis that western southern Africa is the ancestral area of distribution for the genus. The pollen characteristics only reflect the currently accepted sectional subdivision of the genus in the two species of section *Dregeocymbium*. These results prompt a thorough re-examination of macromorphological characters in *Androcymbium* to assess whether the present sectional classification should be modified.

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Biogeography of *Oxalis* (Oxalidaceae) in South Africa: a preliminary study

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Keywords: biogeography, diversity, endemism, Fynbos, *Oxalis* L., refugia, South Africa, Succulent Karoo

ABSTRACT

Oxalis L., commonly called sorrel, is a large and cosmopolitan taxon that has undergone spectacular speciation within southern Africa (± 270 taxa), and more specifically within the winter rainfall regions of the western Cape Region (CR). The main objective of this study was to analyse the geographical distribution of *Oxalis* in South Africa in relation to currently defined phytogeographic units. The observed patterns of biodiversity and endemism within South African members of the genus show interesting disjunctions and concentrations of species. *Oxalis* is one of the few CR taxa that is shared between the core Fynbos and Succulent Karoo Biomes, and this study therefore provides a novel insight into evolutionary trends across, and not only within, these phytogeographic units. The major centre for diversity for *Oxalis* is situated on Table Mountain and the northern areas of the Cape Peninsula (grid square 3318CD). Subsidiary centres are located in the Clanwilliam/Niewoudtville and Kamiesberg regions. The reported patterns in Western Cape suggest that *Oxalis* species richness has been generated and retained in areas which have been identified as core Fynbos (Table Mountain), Fynbos refugia during interglacials (Kamiesberg), and an ecotonal region which might switch between the two biome types (Clanwilliam/ Niewoudtville). Presumably these three types of areas would provide interesting material for DNA-based phylogenetic work, and a test of the climate change 'species-pump' hypothesis proposed by Midgley *et al.* (2001).

INTRODUCTION

Oxalis L. (Oxalidaceae) is a large and cosmopolitan genus, including more than 800 species (Chant 1993). Most of its range is covered by a limited number of species, such as *O. pes-caprae* L. and *O. corniculata* L., which are ubiquitous weeds (Salter 1944).

Oxalis has two well-developed centres of diversity, which represent over 90% of the species. One centre is located in South-Central America, including more than 500 species. The other is in South Africa, more specifically within the Cape Region (CR) (Cowling & Hilton-Taylor 1997), where ± 150 species are found in an area of less than 90 000 km^2, with extensions both northwards and eastwards along the coast. In total, southern Africa hosts ± 270 *Oxalis* taxa (Dreyer 1996). The Cape Region, as defined by Cowling & Hilton-Taylor (1997), coincides with the Fynbos Biome, but also includes enclaves of karoo and forest, which form part of the Succulent Karoo and Forest Biomes respectively (Rutherford & Westfall 1986).

There has been a tremendous degree of speciation among the CR representatives. A number of other families and genera with cosmopolitan distributions exhibit similar patterns of massive speciation within the region. Examples include the Proteaceae, with 330 species in the region, as opposed to roughly 70 species within the rest of Africa (Rebelo 1995), the Restionaceae with 275 species (Cowling & Richardson 1995), the Mesembryanthemaceae, with 1 800 species (Smith *et al.* 1998) and the genus *Erica* L., with 658 species (Goldblatt & Manning 2000).

Possible reasons for the dramatic speciation within the CR have been suggested (Linder 1985; Cowling *et al.* 1992). A combination of topographic gradients (Linder *et al.* 1992) and the regular occurrence of fire (Cowling 1987) have been suggested as the main driving factors towards speciation, although the latter two explanations are not entirely appropriate for the Succulent Karoo Biome, which forms part of the CR. More recently, evidence has been published supporting the 'species pump' hypothesis (Midgley *et al.* 2001) that Pleistocene climate change played a role in determining plant species richness and phytogeographic patterns in the greater Cape Mediterranean region (Goldblatt 1978). Although some work has been done on the distribution of plant species within the CR, it has focused almost exclusively on taxa predominantly confined to the Fynbos Biome, the typical but not exclusive vegetation type of the CR (Oliver *et al.* 1983). Despite some cursory observations by Salter (1944), very little has been published on the distribution of *Oxalis* within South Africa. The aim of this study was to map the distribution of this genus within South Africa, and to analyse the geographical distribution of *Oxalis* in South Africa in relation to currently defined phytogeographic units.

MATERIALS AND METHODS

Data on the distribution of *Oxalis* were obtained from Salter (1944) and the Pretoria Computerised Information System (PRECIS) database. These data were provided in 16th degree grid square increments, and provided distributional information for 237 of the 270 taxa. This is currently the most complete and up-to-date list of biogeographical data available for the genus, given the taxonomic uncertainty within several sections of *Oxalis*. Nevertheless, the total of 237 represents ± 88% of even the most comprehensive list of *Oxalis* taxa, and is thus considered adequate to represent the entire genus within

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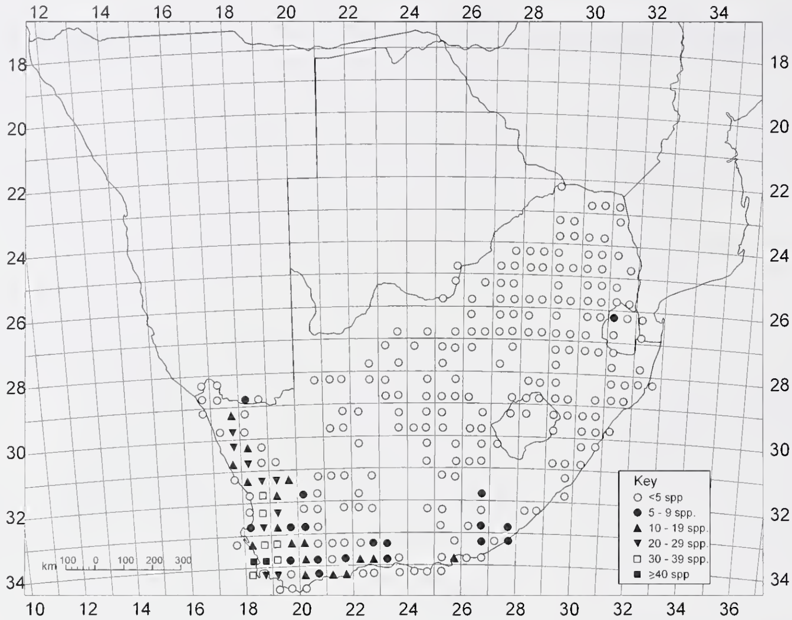

FIGURE 1.—*Oxalis* diversity in South Africa.

the country. Most of the taxa not included are taxonomically unresolved or vague.

Totals for each 16th degree grid square (which would provide taxon numbers for that grid square i.e. richness) and for each taxon restricted to only one, or two adjacent, 16th degree grid squares (i.e. reasonable marker for endemism levels) were extracted.

These data were then summarized at quarter degree grid square level, and the repeats eliminated. The figures were transferred to the appropriate grid squares on maps of South Africa.

RESULTS

Oxalis is distributed throughout the study area (Figure 1), with an observed increase in diversity and endemism levels to the south and west of South Africa (with the notable exception of the Great Karoo), culminating within the CR, where the vast majority of taxa are located. This pattern is a classic example of the distribution of many prominent CR families and genera.

Three centres of diversity were identified. The largest and most speciose is positioned on the Cape Peninsula, extending to the Kogelberg/Hottentot's Holland Mountain Ranges to the east. Although the two ranges are separated by the Cape Flats, they are considered as a single unit for the purposes of this project, because of the high degree of *Oxalis* species shared between them (60%).

A secondary centre of diversity is situated in the Clanwilliam/Niewoudtville region. Although not as speciose as the Hottentots Holland epicentre, this region contains a wide range of unique species, both within *Oxalis* and in other taxonomic groups (Schumann & Kirsten 1992; Rebelo 1995). This epicentre is higher in altitude and further inland than the Cape Peninsula, and thus has a somewhat different, more arid, climate.

The third main centre of *Oxalis* biodiversity is situated in the Kamiesberg region of the Northern Cape. This is a region of extreme botanical interest as the unique Namaqualand and Richtersveld areas, containing many semi-desert paleo- and neo-endemics, surround it. In addition, the region still harbours fynbos taxa (Cowling & Pierce 1999), probably isolated there after the retreat of the last glacial maximum (Midgley *et al.* 2001).

Other minor centres of diversity occur throughout South Africa, but at least two can be considered somewhat biased as they are located near or on major cities, and have therefore been extensively collected. These two sites are located on the Witwatersrand and on Algoa Bay grid squares, the first containing the cities of Johannesburg and Pretoria and the latter the city of Port Elizabeth. The Cape Peninsula centre probably also shows some collecting bias, as it is located on a major city, and is the site of South Africa's main Botanical Gardens at Kirstenbosch. Collection records for the Cape Peninsula are probably much better than for Namaqualand, in part due to the brief and ephemeral appearance of *Oxalis* species. Collectors in more remote areas, which are visited only occasionally and not on such a regular basis as areas around Cape Town, may easily miss these plants. At present no reason can be offered for the existence of other sites, such as the one located in Swaziland and in the East London/Umtata area. The last centre, located on the eastern Langeberg/Outeniqua, could possibly also be a southern Cape refugium.

Oxalis is represented throughout most of the rest of South Africa by only six species, namely *O. depressa* Eckl. & Zeyh., *O. obliquifolia* Steud. ex Rich., *O. obtusa* Jacq., *O. semiloba* Sond., *O. smithiana* Eckl. & Zeyh., and the naturalized American species *O. corniculata* L.

All taxa confined to one, or to two adjacent 16th

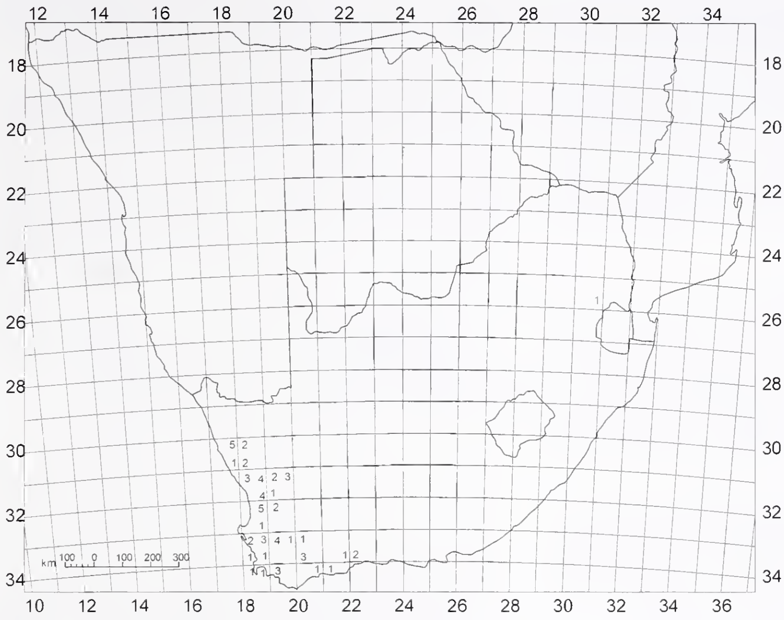

FIGURE 2.—*Oxalis* endemism in South Africa. The numbers refer to the number of endemic species within each quarter degree square.

degree grid squares were considered adequate to represent local scale endemism (Figure 2). Several of the diversity centres are confirmed as centres of endemism, such as the Hottentots Holland, Clanwilliam/Niewoudtville and southern Cape centres. The most speciose square, centred on Table Mountain, contains only one endemic species, which is a surprisingly low value. However, this might be an artefact of scale. The Kamiesberg Centre is not represented. A species regarded as endemic according to our criteria, occurs within southern Mpumalanga, in grid square 2530D. *Oxalis davyana* Knuth is a taxonomically isolated species assigned to a monotypic subsection (Section *Eu-cernuae* subsection *Goetzea*) by Salter (1944), and is biogeographically equally isolated from other centres of endemism.

The top ten hot spots, defined as the ten most speciose squares at 16th degree grid square level, all feature more than 20 species, with four containing 30 species or more (Table 1). Between them, these ten squares contain 137 taxa, ± 58% of the total complement. The most speciose square, centred on Table Mountain, contains 40 species, over one sixth of the total in the database. These areas are top priorities for conservation, at least in terms of *Oxalis* (Rebelo 1994). As mentioned previously, it should be noted that several, if not most of these areas are heavily subject to collecting bias, but this does not invalidate their essential conservation value.

TABLE 1.—Ten most speciose grid squares: *Oxalis* diversity from the PRECIS database

Grid square	Region	No. spp.
3318 CD	Table Mountain	40
3318 DD	Stellenbosch	32
3418 AB	Southern Cape Peninsula	31
3218 BB	Clanwilliam	30
3318 DB	Paarl	28
3017 BB	Southern Kamiesberg	25
3318 DC	Bellville	21
3319 AC	Tulbagh	21
3119 AC	Niewoudtville	21
2917 DB	Northern Kamiesberg	21

DISCUSSION

Oliver *et al.* (1983) have provided a recent comprehensive analysis of CR phytogeography, including a distributional analysis of 1 936 species in Fynbos Biome families. According to this analysis, a typical CR taxon would show a maximum centre of diversity within the Caledon District; more specifically the Kogelberg massif located in grid square 3418BB, with species numbers and endemism levels tailing off towards the north and east. Despite the huge sample size and the undoubted value of the Oliver *et al.* (1983) analysis, their approach has been criticized for focusing exclusively on Fynbos families and ignoring the other major biomes of the CR, namely Succulent Karoo and Afromontane Forest (Bayer 1984). As has been noted by various authors (Levyns 1963; Cowling & Hilton-Taylor 1997), the floras of the three biomes (Rutherford & Westfall 1986) are taxonomically distinct at virtually every level and very few genera are shared between them. *Oxalis* provides a useful exception, in that it is one of the few taxa that is shared between the core Fynbos and Succulent Karoo Biomes. Some others include members of the genus *Pelargonium* L'Hér., section *Hoarea* DC. (Marais 1994), *Crassula* L. as well as certain members of the Mesembryanthemaceae, such as *Ruschia* Schwantes and *Lampranthus* N.E.Br. (Jurgens 1991). It is notable that all of these taxa are adapted to a geophytic or succulent lifestyle.

Midgley *et al.* (2001) point out that geophytic growth forms are resilient to the drought and fire disturbance regimes that characterize both biomes. This would have enabled geophytes to thrive even during periods of climatic change and associated successive replacements of the Succulent Karoo and Fynbos Biomes with one anoth-

er during Pleistocene fluctuations. They offer this as an explanation for the hitherto unexplained diversity of geophytes at the interface between the two biomes. *Oxalis*, which is geophytic in southern Africa, fits this pattern. Thus the most unusual feature of *Oxalis* distribution, the strong representation along the west coast and subsidiary centres of diversity within the Clanwilliam/Niewoudtville and Kamiesberg areas, is easily explained. Bioclimatic modelling suggests that they were some of several fynbos refugia maintained over the last glacial period (Midgley *et al.* 2001).

It is notable that the centre of diversity for *Oxalis* is not situated in the grid square 3418BB, highlighted by Oliver *et al.* (1983), as is the case for many other Fynbos families. The most diverse centre is, in fact, further north and west, on the drier plains of the Boland and West Coast (Table 1). Grid square 3418BB is notably absent from the list of ten most speciose grid squares for *Oxalis*.

Several authors, including Levyns (1963), have indicated that the centre of diversity for the Succulent Karoo is further north and west, to the drier, more Mediterranean parts of the CR, than the typical Fynbos centre. Although *Oxalis* is not a pure Succulent Karoo taxon, our data are consistent with such a conclusion.

In this paper, several of the diversity centres are also confirmed as centres of endemism, such as the Hottentots-Holland, Clanwilliam/Niewoudtville and southern Cape. The fact that the Kamiesberg Centre does not contain *Oxalis* endemics could be due to the recent nature of its isolation from the southwestern Cape region in terms of climate and flora. The Kamiesberg Fynbos outlier may have been isolated for only roughly 12 000 to 15 000 years (since the end of the Pleistocene). This could mean that not enough time has elapsed for consequent genetic isolation and speciation to occur. This is supported by observations in other families in the region. Of the seven *Erica* species that occur on the Kamiesberg, all seven are also represented further south (Cowling & Pierce 1999), and both Proteaceae species, although endemic, are closely related to southern species (Rebelo 1995; Reeves 2001).

In conclusion, *Oxalis* is one of few genera that exploit both the Succulent Karoo and Fynbos Biomes successfully and prolifically. Thus this genus provides an excellent opportunity to assess various hypotheses relating to diversification in the CR. Richardson *et al.* (2001) produced the first DNA phylogeny that suggests a recent rapid floristic diversification in the CR. The geographic distribution of taxon richness within *Oxalis* discussed in this paper, sets the stage for further promising DNA-based phylogenetic work in this region. Such an approach will be critical in developing an understanding of the factors responsible and the time scales involved in the genesis of the floristic biodiversity hotspots of the fire-prone Fynbos and drought-prone Succulent Karoo Biomes.

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A checklist of the plants of Mahwaqa Mountain, KwaZulu-Natal

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Keywords: afromontane, Bulwer, checklist, flora, grassland, KwaZulu-Natal, South Africa

ABSTRACT

A checklist of the plants of Mahwaqa Mountain, KwaZulu-Natal, is presented. The list includes 1 030 indigenous and naturalized flowering plants and ferns. Comparisons are made with the floras of KwaZulu-Natal (Ross 1972), the Cape of Good Hope Nature Reserve, Cape Point (Taylor 1985), the southern Natal Drakensberg (Hilliard & Burtt 1987), the Amatolas (Phillipson 1987), the Langeberg (McDonald 1999) and Umtamvuna Nature Reserve (Abbott *et al.* 2000). It is hoped that the publication of this list will contribute towards the recognition of the area as a natural heritage site.

INTRODUCTION

The Grassland Biome covers 343 000 km^2 or 16.5% of the land area in South Africa and supports the greatest human population densities and the highest levels of agricultural utilization on the subcontinent, consequently it is under considerable conservation threat. Only 1.12% of South African grasslands are currently conserved despite the fact that they contain high levels of floristic diversity (Rutherford & Westfall 1994). Some idea of the heterogeneity of the Grassland Biome can be gleaned from the fact that it accommodates 25 of Acocks's veld types. Comparative aspects of biodiversity are limited by size disparity in the geographic areas under consideration. However, it is pertinent to mention that our collections from this single mountain exceed 1 000 spp. and the whole of the Cape Peninsula was estimated to support in the region of 2 622 spp. (Adamson & Salter 1950).

Mahwaqa Mountain falls into the Zambezian Subregion which boasts a number of endemic genera, most of which are concentrated in Angola and in the Drakensberg system, in fact the latter is characterized by a high percentage of local endemics (Takhtajan 1986; Hilliard & Burtt 1987; Cowling & Hilton-Taylor 1997). The mountain falls under Acocks's (1988) Veld Type 44a, Highland Sourveld. About 51.3% of this veld type occurs in KwaZulu-Natal and, of this, 8.7% is protected. Unfortunately, the great majority of conserved vegetation falls within a single reserve, Natal Drakensberg Park, and consequently geographic diversity is under-represented (Scott-Shaw *et al.* 1996). To address this problem it is essential to have information pertaining to the floristic diversity in geographically distinct areas. In this way the conservation importance of such areas, under the threat of agricultural exploitation, can be assessed in some detail.

Mahwaqa Mountain is an outlier of the main Drakensberg and is situated about 50 km to the south of Drakensberg Gardens between 29° 40'S and 29° 50'S latitude and 29° 38'W and 29° 40'W longitude. The mountain is almost completely surrounded by cultivated land, with the Mossbank Plantation to the south and farmlands to the north, east and west. This situation is dynamic with an ever increasing number of farmers planting exotic timber.

The mountain lies within Turner's (Philips 1973) physiographic region—Bulwer Block—with an altitudinal range of 1 700 m to almost 2 000 m above sea level. The highest point of Mahwaqa Mountain (2 075 m) comprises a basalt cap overlying Clarens Sandstone, with yellow and red apedal, freely drained, dystrophic soils, which have a tendency to be highly leached (Van Oudtshoorn 1992).

Mahwaqa is in the summer rainfall region of southwestern KwaZulu-Natal, with peak precipitation between November and March (Schulze 1982). The summit of the mountain is largely grassland, but intact patches of indigenous forest occur in the sheltered areas, from which fire is excluded, and the largest of these is Inkelabantwana Forest.

The vegetation on a large portion of the mountain is fairly pristine and forms part of a biosphere reserve. Extensive collections have been made by M.A. Rennie on Sunset and Glengariff Farms which are adjacent to the biosphere reserve and reach a maximum elevation of 1 985 m.

MATERIALS AND METHODS

Provisional species inventories for the area were obtained from M.A. Rennie and species lists (no voucher specimens) were provided by R. Scott-Shaw and K. Cooper. In most instances this information was verified and supplemented by a study of herbarium specimens in the Natal University Herbarium (NU) and by a literature search. PRECIS [National Herbarium, Pretoria (**PRE**) **C**omputerised **I**nformation **S**ystem] was consulted and the relevant data was extracted and cross-referenced with voucher specimens at PRE. For the most part, the arrangement of the checklist conforms to the Englerian

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system, followed by De Dalla Torre & Harms (1907) and Arnold & De Wet (1993). The liverworts follow Perold (1999). Naturalized weeds are marked with an asterisk (*).

RESULTS AND DISCUSSION

The flora of Mahwaqa Mountain includes well over 1 000 indigenous species (Table 1) and this constitutes over 21% of the diversity in KwaZulu-Natal (with the total number of Anthophyta for KwaZulu-Natal being 4 875; Hilliard & Burtt 1987). This α-diversity compares favourably with the Amatole Mountains, 1 215 spp. (Phillipson 1987), the Langeberg, 1 228 spp. (McDonald 1999) and Umtamvuna Nature Reserve, 1 332 spp. (Abbott *et al.* 2000).

There are 45 pteridophytes comprising 4.4% of the mountain's flora. The ratio of monocotyledons to dicotyledons on Mahwaqa is 1: 2.1. Ten families of flowering plants are very well represented and collectively constitute over half (53%) of the total species (Table 2). Nineteen families each contribute more than 1% to the total number of species, collectively accounting for 67% of the species. It is interesting to note that the diversity of pteridophytes is high at the family level but low at the species level. Conversely, the monocotyledons show a trend with proportional increments at the generic and species levels. This possibly indicates a fairly low number of families rapidly speciating in conjunction with the spread of the Grassland Biome.

The floristics of many South African habitats are dominated by the Asteraceae (Taylor 1985; Westfall *et al.* 1986; Hilliard & Burtt 1987; Van Wyk *et al.* 1988; Deall & Backer 1989). This family is also dominant on Mahwaqa Mountain (15.6%, Tables 2; 3). Asteraceae is represented by fewer species on Mahwaqa than in the southern Drakensberg, but are better represented on the Mountain than in KwaZulu-Natal as a whole (Table 3). This trend in the data was expected, as Asteraceae is the largest family in KwaZulu-Natal and its highest diversity occurs in the Drakensberg (Hilliard 1978). The family is characterized by speciation in the Grassland Biome, the major habitat on Mahwaqa Mountain. The higher species diversity recorded in the southern Drakensberg (Hilliard & Burtt 1987) probably reflects the recruitment of Cape elements in this region and the Amatolas and Langeberg show similar levels of diversity (Table 4). Within the Asteraceae a number of southern Drakensberg endemics have been recorded from the mountain including *Felicia linearis, Helichrysum sessilioides, H. vernum, Osteospermum attenuatum, Othonna burttii, Senecio dregeanus, S. hirsutilobus* and *Vernonia flanaganii*.

TABLE 1.—Number of families, genera and species of Pteridophyta, Monocotyledonae and Dicotyledonae recorded on Mahwaqa Mountain, KwaZulu-Natal

	Pteridophyta		Monocotyledonae		Dicotyledonae		
	No.	%	No.	%	No.	%	Total
Families	17	12.6	22	16.3	96	71.1	135
Genera	25	5.5	132	29.3	294	65.2	451
Species	45	4.4	322	31.3	663	64.4	1030

TABLE 2.—Synopsis of families which contribute 1% or more of total number of species for Mahwaqa, together with number of genera in each family

Family	Genera		Species	
	No.	% of total	No.	% of total
Asteraceae	46	10.8	168	15.6
Poaceae	51	12.0	91	8.4
Orchidaceae	18	4.2	85	7.9
Fabaceae	19	4.5	55	5.0
Scrophulariaceae	20	4.7	44	3.7
Iridaceae	10	2.3	43	3.7
Asclepiadaceae	10	2.3	33	3.0
Hyacinthaceae	10	2.3	29	2.7
Cyperaceae	12	2.8	26	2.4
Lamiaceae	10	2.2	24	2.1
Rubiaceae	13	2.9	24	2.1
Asphodelaceae	4	0.9	23	2.1
Apiaceae	10	2.2	12	1.2
Geraniaceae	3	0.7	12	1.2
Crassulaceae	2	0.4	12	1.1
Aspleniaceae	1	0.2	12	1.1
Lobeliaceae	3	0.7	11	1.0
Rosaceae	7	1.5	11	1.0
Thymelaeaceae	4	0.9	11	1.0

Poaceae is the second most diverse family in the study area (Tables 2; 3), dominating in terms of biomass, as the mountain falls primarily within the Grassland Biome. Grasses also constitute one of the main contributors to the Natal flora (Hilliard 1978). Gibbs Russell *et al.* (1990) identified a number of endemic Drakensberg grasses, some of which occur on the mountain (*Agrostis barbuligera* var. *barbuligera, Cynodon hirsutus, Digitaria tricholaenoides, Helictotrichon longifolium, Merxmuellera stricta, Pentaschistis exserta, P. setifolia, Setaria obscura* and *Sporobolus pectinatus*). The family is less speciose to the south and accounts for only 3% of the diversity on the Langeberg, where fynbos dominates (Table 5).

The apparent disparity between Table 2 and 3 with respect to the position of the Fabaceae is the result of the Liliaceae *s.l.* being treated as a single entity in Table 3 and being reduced to its component families in Table 2. This modification allows direct comparison with Hilliard (1978) and Ross (1972) which deal with Liliaceae *s.l.* In Table 2, Fabaceae is fourth on the list of species contributors. Hilliard & Burtt (1987) state that Fabaceae is the

TABLE 3.—The nine largest families and their contribution to the floras of Mahwaqa Mountain, the southern Drakensberg and KwaZulu-Natal (with Scrophulariaceae including Selaginaceae and Liliaceae *s.l.*)

Mahwaqa Mountain			Southern Drakensberg		KwaZulu-Natal	
Family	sp.	%	sp.	%	sp.	%
Asteraceae	168	16.0	285	21.4	577	11.8
Poaceae	91	8.4	108	8.1	370	7.6
Orchidaceae	85	7.9	83	6.2	218	4.5
Liliaceae *s.l.*	60	5.8	84	6.3	247	5.1
Fabaceae	55	5.1	65	4.9	413	8.4
Scrophulariaceae	44	4.2	79	5.9	177	3.6
Iridaceae	43	3.9	65	4.9	-	-
Asclepiadaceae	33	3.1	44	3.3	234	4.8
Cyperaceae	26	2.3	59	4.4	59	4.4
Euphorbiaceae	-	-	-	-	146	3.0

TABLE 4.—Genera which contribute 10 or more species to the flora of Mahwaqa Mountain (M) in order of numerical importance and in relation to the floras of the southern Drakensberg (SD), Amatola Mountains (A), Langeberg (L), Cape Point (CP), and Umtamvuna Nature Reserve (UNR)

Genus	M	SD	A	L	CP	UNR
Helichrysum (Asteraceae)	39	84	48	15	10	34
Senecio (Asteraceae)	37	72	46	24	19	26
Disa (Orchidaceae)	16	24	13	27	11	10
Kniphofia (Asphodelaceae)	14	14	6	1	1	5
Asclepias (Asclepiadaceae)	12	13	6	0	0	2
Asplenium (Aspleniaceae)	12	7	12	3	1	4
Lotononis (Fabaceae)	12	11	2	2	0	5
Crassula (Crassulaceae)	11	17	13	8	17	12

second most important species contributor to the KwaZulu-Natal flora (Table 3). The lower diversity of this family on the mountain is partly due to absence of tropical tree and shrub species in the elevated grasslands. The disparity is borne out by comparison between Mahwaqa Mountain and Umtamvuna Nature Reserve (Table 5). Four endemics to the southern Drakensberg, *Argyrolobium nigrescens, A. sericosemium, Indigofera woodii* and *Lotononis virgata*, occur on the mountain.

The Orchidaceae is well represented in mountain floras of the eastern seaboard and is the third most speciose family on Mahwaqa Mountain (85 taxa) and the fourth most in the southern Drakensberg (83 spp.). Only two of the Mahwaqa species are narrow endemics, *Huttonaea oreophila* and *Pterygodium cooperi*. The diversity of orchids on Mahwaqa and in the southern Drakensberg is higher than in any of the compared areas (Tables 3–5).

Liliaceae *s.l.* contributes 5.8% or 60 spp. to the Mahwaqa flora (Table 3), which correlates closely with the family's importance in the southern Drakensberg (6.3% or 84 spp.) and for the flora of KwaZulu-Natal (247 species or 5.1%). When broken down into component families (*sensu* Dahlgren *et al.* 1985) the Hyacinthaceae is best represented in the southern Drakensberg with 34 species (Hilliard & Burtt 1987). This pattern is repeated on Mahwaqa Mountain where 29 species of Hyacinthaceae occur (2.7%). The Asphodelaceae is also well represented on the mountain with 23 species compared with the 19 species listed by Hilliard & Burtt (1987) for the southern Drakensberg. In *Kniphofia*, a number of species are outlined as narrow endemics by Codd (1968) and of these *K. ichopensis, K. brachystachya* and *K. fibrosa* occur on Mahwaqa Mountain. The area is also the northern limit of *K. parviflora*.

The Iridaceae contributes a large number of species (43 or 4%) to the Mahwaqa Mountain flora (Table 2). The family has a peak of diversity in the mountains and winter rainfall areas of sub-Saharan Africa (Goldblatt 1983) (Table 4). The Iridaceae is the seventh largest family in the southern Drakensberg (65 or 4.9 %) (Hilliard & Burtt 1987) and similar levels of diversity are seen on the Langeberg (5%) (McDonald 1999). Five of the species recorded from Mahwaqa are endemic to the southern Drakensberg, *Moraea hiemalis, M. unibracteata, M. carnea* (Goldblatt 1986), *Gladiolus parvulus* (Goldblatt & Manning 1998) and *Hesperantha grandiflora* (Hilliard & Burtt 1986).

Scrophulariaceae (including Selaginaceae) are important in the southern Drakensberg where they constitute 5.9% of the species (Hilliard & Burtt 1987). On Mahwaqa the family is slightly less important, contributing 4.2% or 44 species which is comparable to that for KwaZulu-Natal at 3.6% (Hilliard & Burtt 1987). This diversity includes three narrowly distributed species, *Manulea florifera, Nemesia silvatica* and *Diascia megathura.*

The Asclepiadaceae, now included under Apocynaceae (Leistner 2000), display similar levels of diversity on Mahwaqa and in the southern Drakensberg (3.1% and 3.4% respectively), but these levels are considerably lower than the diversity in KwaZulu-Natal (Ross 1972). This is probably due to the exclusion of tropical and xerophytic species from the montane habitats. A number of mesic asclepiads appear to have speciated in the Natal Drakensberg and of these *Aspidonepsis flava, A. reenensis, A. diploglossa* and *Schizoglossum elingue* subsp. *elingue* have been recorded on the Mountain. A comparison with floristic inventories to the south, show that the Asclepiadaceae are insignificant in their contribution to the flora of the Langeberg.

A few other near-endemic species occur in the less diverse families on the mountain. These include: *Peucedanum thodei* (Apiaceae), *Geranium pulchrum* (Geraniaceae), *Gnidia renniana* (Thymelaeaceae), *Gymnosporia uniflora* subsp. nov. (M. Jordaan pers. comm.) (Celestraceae), *Afrotysonia glochidiata* (Boraginaceae),

TABLE 5.—The ten most speciose families on Mahwaqa Mountain and their relative diversity on the Amatola Mountains (Phillipson 1987), Langeberg (McDonald 1999), Cape Point (Taylor 1985) and Umtamvuna Nature Reserve (Abbott *et al.* 2000)

	Mahwaqa		Amatolas		Langeberg		Cape Point		Umtamvuna	
Family	spp.	%	spp.	%	spp.	%	spp.	%	spp.	%
Asteraceae	168	15	204	17	167	14	120	11	149	12
Poaceae	91	8	80	7	41	3	64	6	66	5
Orchidaceae	85	8	53	4	56	5	59	5	42	3
Liliaceae *s.l.*	60	6	54	4	28	2	44	4	57	4
Fabaceae	55	5	67	6	93	8	70	6	101	8
Scrophulariaceae	44	4	43	4	27	2	24	2	28	2
Iridaceae	43	4	33	3	55	5	78	7	34	3
Asclepiadaceae	33	3	27	2	4		3		31	2
Cyperaceae	26	2	61	5	56	5	74	7	31	2
Total spp. no. (vascular plants)	1080		1215		1228		1091		1332	

Satureja reptans and *Hemizygia cinerea* (Lamiaceae), *Wahlenbergia pallidiflora* (Campanulaceae), *Cyphia natalensis* (Lobeliaceae).

Table 4 shows that eight genera have 10 species or more, with *Senecio* and *Helichrysum* contributing 37 and 39 species respectively.

It is clear from the data above that Mahwaqa Mountain supports a highly diverse flora and is a strong candidate for long-term preservation. The area approaches the Amatola and the Langeberg Mountains in terms of its α-diversity despite being a fraction of the land area. In addition, α-diversity is comparable to that of Umtamvuna Nature Reserve of the Pondoland Centre, which is renowned for its phytodiversity (Van Wyk 1990, 1994). The levels of endemism are considerably lower than those of the Langeberg and the Pondoland Centre although numerous southern Drakensberg endemics occur on the mountain.

One of the most insidious threats to the diversity of indigenous grasslands, is their invasion by opportunist seedlings from timber plantations. This threat is in the form of timber species, such as eucalypts and pines, as well as weeds from these plantations. Changing burning regimes, due to the high risk that fire poses to timber plantations, allow the proliferation of woody species which are intolerant of fire. Pyrophytes, which constitute the bulk of the indigenous vegetation, are rapidly lost from these altered moribund habitats. The ubiquitous and irresponsible degradation of grasslands in KwaZulu-Natal is a serious indictment on agroforestry in the province. Hopefully the vegetation of Mahwaqa Mountain will not succumb to the invasion of weeds and opportunist seedlings from the surrounding plantations.

SYSTEMATIC LIST

The angiosperm nomenclature is arranged according to Arnold & De Wet (1993), Leistner (2000), and species are arranged alphabetically within each genus. The nomenclature of Asparagaceae follows Fellingham & Meyer (1995). Synonyms in italics in brackets follow unpublished PRECIS lists.

Putative hybrids and subspecific taxa are excluded from the above tables but are included in the checklist. Most of the cited vouchers are housed in the Natal University Herbarium (NU), Pietermaritzburg and at the National Herbarium, Pretoria (PRE). Voucher slides of the bryophytes are housed at NU.

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CHECKLIST

* Naturalized weeds. Italicized names in square brackets are synonyms in PRECIS.

HEPATOPHYTA

RICCIACEAE
Riccia stricta *(Lindenb.) Perold*
MARCHANTIACEAE
Marchantia cf. polymorpha *L.*

AYTONIACEAE
Asterella sp.
Plagiochasma sp.

PLAGIOCHILACEAE
Plagiochila sp.

LOPHOCOLEACEAE
Lophocolea sp.

ANTHOCEROTOPHYTA

ANTHOCEROTACEAE
Anthoceros sp.

BRYOPHYTA

FISSIDENTACEAE
Fissidens glaucescens *Hornsch.*

DITRICHACEAE
Ditrichum brachypodum *(Müll.Hal.) Broth.*

DICRANACEAE
Campylopus pilifer *Brid.*

POTTIACEAE
Barbula crinita *Schultz*
Trichostomum brachydontium *Bruch*
Bryoerythrophyllum jamesonii *(Taylor) H.A.Crum*

FUNARIACEAE
Funaria hygrometrica *Hedw.*

BRYACEAE
Anomobryum filiforme *(Dicks.) Husn.*
Bryum
  alpinum *Huds. ex With.*
  pseudotriquetrum *(Hedw.) P.Gaertn., B.Mey. & Scherb.*
  pycnophyllum *(Dixon) Mohamed*
Mielichhoferia
  bryoides *(Harv.) Wijk & Margad.*
  subnuda *Sim*
Rhodobryum roseum *(Hedw.) Limpr.*

MNIACEAE
Plagiomnium rhynchophorum *(Hook.) T.J.Kop.*

BARTRAMIACEAE
Bartramia hampeana *Müll.Hal.*
Philonotis
  africana *(Müll.Hal.) Rehmann ex Paris.*
  dregeana *(Müll.Hal.) A.Jaeger*
  falcata *(Hook.) Mitt.*

ORTHOTRICHACEAE
Macrocoma tenuis *(Hook. & Grev.) Vitt*

LESKEACEAE
Pseudoleskeopsis sp.

THUIDIACEAE
Haplocladium sp.
Thuidium sp.

HYPNACEAE
Hypnum cupressiforme *Hedw.*

POLYTRICHACEAE
Atrichum androgynum *(Müll.Hal.) A.Jaeger*

POLYSTICHACEAE
Oligotrichum cf. afrolaevigatum *(Dixon) G.L.Sm.*

PTERIDOPHYTA

LYCOPODIACEAE
Lycopodium
  clavatum *L., Rennie 630* NU
  verticillatum *L.f., Feltham 166* NU

SELAGINELLACEAE
Selaginella
  kraussiana *(Kunze) A.Braun ex Kuhn, Edwards 2203* NU
  mittenii *Baker, Rennie 515* NU
EQUISETACEAE
Equisetum ramosissimum *Desf., Rennie 1752* NU

OPHIOGLOSSACEAE
Ophioglossum vulgatum *L., Rennie 1766* NU

ANEMIACEAE
Mohria caffrorum *(L.) Desv., Rennie 917* NU

GLEICHENIACEAE
Gleichenia umbraculifera *(Kunze) T.Moore, Rennie 670* NU

CYATHEACEAE
Cyathea dregei *Kunze, Rennie s.n.* NU

PTERIDACEAE
Adiantum poiretii *Wikstr., Edwards 1982* NU
Cheilanthes
  eckloniana *(Kunze) Mett., Rennie 1926* NU
  hirta *Sw., Rennie 577* NU
  quadripinnata *(Forssk.) Kuhn, Rennie 587, 904* NU
Pellaea
  calomelanos *(Sw.) Link, Rennie 876* NU
  pteroides *(L.) Prantl, Rennie 904* NU
Pteris
  catoptera *Kunze, Clarkson s.n.* NU
  cretica *L., Vos 68* NU

POLYPODIACEAE
Loxogramme lanceolata *(Sw.) C.Presl, Clarkson s.n.* NU
Pleopeltis macrocarpa *(Bory ex Willd.) Kaulf., Feltham 266* NU
Lepisorus schraderi *(Mett.) Ching, Rennie 514* NU
Polypodium
  polypodioides *(L.) Hitchc.* subsp. ecklonii *(Kunze) Schelpe, Clarkson s.n.* NU
  vulgare *L., Rennie 895* NU

*NEPHROLEPIDACEAE
*Nephrolepis undulata *(Sw.) J.Sm., Rennie 895* PRE

ASPLENIACEAE
Asplenium
  adiantum-nigrum *L., McBean s.n.* NU
  aethiopicum *(Burm.f.) Bech., Rennie 916* NU
  boltonii *Hook. ex Schelpe, Clarkson s.n.* NU
  erectum *Bory ex Willd., Edwards 2027* NU
  lobatum *Pappe & Rawson, Clarkson s.n.* NU
  monanthes *L., Feltham 300* NU
  protensum *Schrad., Clarkson s.n.* NU
  rutifolium *(P.J.Bergius) Kunze, Shuter s.n.* NU
  splendens *Kunze, Feltham 279* NU
  stoloniferum *Bory, Feltham 293* NU
  theciferum *(Kunth) Mett.* var. concinnum *(Schrad.) Schelpe, Clarkson s.n.* NU
  varians *Hook. & Grev.* subsp. fimbriatum *(Kunze) Schelpe, Clarkson s.n.* NU

THELYPTERIDACEAE
Thelypteris pozoi *(Lag.) C.V.Morton, Clarkson 194* NU

ATHYRIACEAE
Athyrium schimperi *Moug. ex Fée, Clarkson s.n.* NU

DRYOPTERIDACEAE
Cystopteris fragilis *(L.) Bernh., Clarkson s.n.* NU

Dryopteris
athamantica *(Kunze) Kuntze, Rennie 1311* NU
inaequalis *(Schltdl.) Kuntze, Edwards 2210* NU
Polystichum
luctuosum *(Kunze) Moore, Rennie 546; Edwards 1943* NU
pungens *(Kaulf.) C.Presl, Edwards 1942* NU
transvaalense *N.C.Anthony, Rennie 1441* NU

LOMARIOPSIDACEAE
Elaphoglossum
acrostichoides *(Hook. & Grev.) Schelpe, Rennie 1512* NU, PRE
drakensbergense *Schelpe, Feltham 179* NU

ASPIDIACEAE
Cyrtomium caryotideum *(Hook. & Grev.) C.Presl* var. micropterum *(Kunze) C.Chr., Feltham 270* NU
Woodsia montevidensis *(Spreng.) Hieron.* var. burgessiana *(Gerrard ex Hook. & Baker) Schelpe, Rennie 1685* NU

BLECHNACEAE
Blechnum
attennuatum *(Sw.) Mett.* var. giganteum *(Kaulf.) Bonap., Clarkson s.n.* NU
inflexum *(Kunze) Kuhn, Feltham 296* NU

GYMNOSPERMAE

PODOCARPACEAE
Podocarpus
falcatus *(Thunb.) R.Br. ex Mirb., Feltham 222* NU
henkelii *Stapf ex Dallim. & Jacks., Rennie 1067* NU
latifolius *(Thunb.) R.Br. ex Mirb., Feltham 227* NU

ANGIOSPERMAE-MONOCOTYLEDONAE

TYPHACEAE
Typha capensis *(Rohrb.) N.E.Br., Rennie 2529* NU

APONOGETONACEAE
Aponogeton junceus *Lehm. ex Schltdl., Rennie 240* NU

POACEAE
Hemarthria altissima *(Poir.) Stapf & C.E.Hubb., Rennie 1760* PRE
Elionurus muticus *(Spreng.) Kunth, Rennie 946* NU
Imperata cylindrica *(L.) Raeusch., Rennie 1533* PRE
Microstegium nudum *(Trin.) A.Camus, Feltham 288* NU
Miscanthus capensis *(Nees) Anderss., Rennie 1557* PRE
Eulalia villosa *(Thunb.) Nees, Rennie 1539* PRE
Andropogon
amethystinus *Steud., Rennie 1359* NU
appendiculatus *Nees, Feltham 15a* NU
eucomus *Nees, Rennie 1771* NU
Cymbopogon
plurinodis *(Stapf) Stapf ex Burtt Davy, Feltham 67* NU
validus *(Stapf) Stapf ex Burtt Davy, Rennie 1586* PRE
Hyparrhenia
dregeana *(Nees) Stapf, Rennie 1757* PRE
hirta *(L.) Stapf, Rennie 1751* PRE
Monocymbium ceresiiforme *(Nees) Stapf, Rennie 1645* PRE
Trachypogon spicatus *(L.f.) Kuntze, Rennie 1656* NU, PRE
Heteropogon contortus *(L.) Roem. & Schult., Feltham 22* NU
Diheteropogon
amplectens *(Nees) Clayton, Rennie 1599* NU
filifolius *(Nees) Clayton, Rennie 1547* PRE
Themeda triandra *Forssk., Rennie 1552* PRE
Digitaria tricholaenoides *Stapf, Rennie 1531* PRE
Alloteropsis semialata *(R.Br.) Hitchc.* subsp. eckloniana *(Nees) Gibbs-Russ., Rennie 1530* PRE
Brachiaria serrata *(Thunb.) Stapf, Rennie 1532* PRE
Echinochloa crus-galli *(L.) P.Beauv., Rennie 1683* NU
Oplismenus hirtellus *(L.) P.Beauv., Edwards 1963* NU
Panicum
aequinerve *Nees, Edwards 2009* NU
ecklonii *Nees, Feltham 172* NU
natalense *Hochst., Rennie 1518* PRE; *Carbutt 453* NU
schinzii *Hack., Rennie 1627* PRE
subalbidum *Kunth, Rennie 1434* NU
Setaria
incrassata *(Hochst.) Hack., Rennie 1344* NU
nigrirostris *(Nees) T.Durand & Schinz, Rennie 1551* PRE
obscura *de Wit, Rennie 1358* NU
pallide-fusca *(Schumach.) Stapf & C.E.Hubb., Rennie 1626* PRE
Melinis
nerviglumis *(Franch.) Zizka, Carbutt 430* NU
repens *(Willd.) Zizka* subsp. repens, *Rennie 1380* NU
Pennisetum
sphacelatum *(Nees) T.Durand & Schinz, Carbutt 448* NU
thunbergii *Kunth, Rennie 1537* PRE
Leersia hexandra Sw., *Rennie 1763* PRE
Ehrharta erecta *Lam.* var. natalensis *Stapf, Rennie 1555* PRE
*Phalaris arundinacea *L., Rennie 1701* PRE
Anthoxanthum ecklonii *(Nees ex Trin.) Stapf, Rennie 1740* PRE; *Carbutt 451* NU
Tristachya leucothrix *Nees, Rennie 1543* PRE
Loudetia
simplex *(Nees) C.E.Hubb., Rennie 1774* PRE
sp., *Rennie 1545* PRE
*Holcus lanatus *L., Feltham 220* NU
Helictotrichon
galpinii *Schweick., Rennie 1391* NU
longifolium *(Nees) Schweick., Rennie 1553* PRE
turgidulum *(Stapf) Schweick., Feltham 285* NU
sp., *Rennie 1520, 1534* PRE
Merxmuellera stricta (Schrad.) Conert, *Rennie 1548* PRE
Pentaschistis
exserta *H.P.Linder, Rennie 1568* NU
natalensis *Stapf, Rennie 1648* NU, PRE
oreodoxa *Schweick., Rennie 1568* PRE
setifolia *(Thunb.) McClean, Rennie 1522* NU, PRE
tysonii *Stapf, Carbutt 449* NU
Phragmites australis *(Cav.) Steud., Rennie 1430* NU
Agrostis
barbuligera *Stapf* var. barbuligera, *Rennie 1738* PRE
bergiana *Trin.* var. bergiana, *Feltham 314* NU
continuata *Stapf, Rennie 1567* NU, PRE
lachnantha *Nees* var. lachnantha, *Rennie 1566* PRE
Aristida junciformis *Trin. & Rupr.*
subsp. galpinii *(Stapf) De Winter, Rennie 1544* PRE
subsp. junciformis, *Rennie 1431* NU
Stipa dregeana *Steud., Edwards 2033* NU
Sporobolus
africanus *(Poir.) Robyns & Tournay, Rennie 1628* NU, PRE
centrifugus *(Trin.) Nees,*
macranthelus *Chiov.,*
pectinatus *Hack., Rennie 1403* NU, *1546* PRE
pyramidalis *P.Beauv., Feltham 10* NU
Eragrostis
caesia *Stapf, Feltham 414* NU
capensis *(Thunb.) Trin., Rennie 1540* PRE
curvula *(Schrad.) Nees, Rennie 1392a* NU; *Vorster 228* PRE
plana *Nees, Rennie 1772* PRE
planiculmis *Nees, Rennie 1629* NU
racemosa *(Thunb.) Steud, Rennie 1418* NU, *1529* PRE
Rendlia altera *(Rendle) Chiov., Feltham 16* NU
Microchloa caffra *Nees., Edwards 2227* NU
Cynodon hirsutus *Stent, Rennie 1406* NU, *1753* PRE
Harpochloa falx *(L.f.) Kuntze, Rennie 941* NU, *1550* PRE
Eleusine coracana *(L.) Gaertn.* subsp. africana *(Kenn.-O'Byrne) Hilu & De Wet, Rennie 1756* PRE
Styppeiochloa gynoglossa *(Gooss.) De Winter, Feltham 9* NU
Koeleria capensis *(Steud.) Nees, Rennie 1523* PRE
*Dactylis glomerata *L., Rennie 1699* PRE
Stiburus alopecuroides *(Hack.) Stapf, Feltham 415* NU
Poa binata *Nees, Rennie 606* NU
Festuca
caprina *Nees, Feltham 70* NU
costata *Nees, Feltham 69* NU
scabra *Vahl, Rennie 1524* NU, PRE
*Vulpia myuros *(L.) C.C.Gmel., Rennie 1389* NU
Bromus
*catharticus *Vahl, Rennie 1345* NU, *1536* PRE
leptoclados *Nees, Rennie 1561*
speciosus *Nees, A.*, Rennie's list
Brachypodium flexum *Nees, Rennie 1765* NU, PRE

CYPERACEAE
Ascolepis capensis *(Kunth) Ridl., Rennie 1697* PRE
Cyperus
albostriatus *Schrad., Edwards 1983* NU
esculentus *L., Rennie 1700* PRE
fastigiatus *Rottb., Rennie 1342* PRE
obtusiflorus *Vahl* var. sphaerocephalus *(Vahl) Kük., Feltham 118* NU

Cyperus (cont.)
rupestris *Kunth* var. rupestris, *Edwards 2060* NU
semitrifidus *Schrad.* var. semitrifidus, *Feltham 44* NU
Pycreus
betschuanus *(Boeck.) C.B.Clarke, Rennie 1690* PRE
flavescens *(L.) Rchb.. Feltham 190* NU
oakfortensis *C.B.Clarke, Rennie 1413* NU
Mariscus
congestus *(Vahl) C.B.Clarke, Rennie 1037* NU
solidus *(Kunth.) Vorster, Edwards 2202* NU
Ficinia stolonifera *Boeck., Rennie s.n.*
Fuirena pubescens *(Poir.) Kunth, Rennie 1277* NU, *1554* PRE
Scirpus falsus *C.B.Clarke, Feltham 180* NU
Isolepis
costata *A.Rich.* var. macra *(Boeck.) B.L.Burtt, Rennie s.n.*
fluitans *(L.) R.Br., Rennie 1353* NU
Bulbostylis
humilis *(Kunth) C.B.Clarke, Feltham 343* NU
oritrephes *(Ridl.) C.B.Clarke, Rennie 1535* PRE
scleropus *C.B.Clarke, Rennie s.n.* NU
Rhynchospora brownii *Roem. & Schult., Rennie s.n.*
Schoenoxiphium
rufum *Nees, Rennie 1029* NU
schweickerdtii *Merxm. & Podlech, Rennie 1646* NU, PRE
Carex
acutiformis *Ehrh., Rennie 1145* NU
mossii *Nelmes, Edwards 2228* NU

ARACEAE
Zantedeschia
aethiopica *(L.) Spreng., Rennie 1020* NU
albomaculata *(Hook.) Baill., Rennie 1001* NU

XYRIDACEAE
Xyris
capensis *Thunb., Feltham 148* NU
gerrardii *N.E.Br., Feltham 239* NU

ERIOCAULACEAE
Eriocaulon dregei *Hochst.* var. sonderianum *(Koern.) Oberm., Rennie 1350* NU

COMMELINACEAE
Commelina africana *L., Feltham 198* NU
Cyanotis speciosa *(L.f.) Hassk., Rennie 625* NU

JUNCACEAE
Juncus
effusus *L., Rennie 1041* NU
exsertus *Buchen., Feltham 334* NU
oxycarpus *E.Mey. ex Kunth, Rennie 1354* NU, *1693* PRE

COLCHICACEAE
Sandersonia aurantiaca *Hook., Feltham 86* NU
Androcymbium longipes *Baker, Rennie 2524* NU
Wurmbea
angustifolia *B.Nord., Feltham 48* NU
elatior *B.Nord., Rennie 1241* NU
Littonia modesta *Hook., Feltham 79* NU

ASPHODELACEAE
Bulbine
capitata *Poelln., Rennie 1195* NU
favosa *(Thunb.) Schult. & Schult.f., Rennie 870* NU
filifolia *Baker, Rennie 498* E, NU
Trachyandra
asperata *Kunth, Rennie 455* NU
gerrardii *(Baker) Oberm., Rennie 456* NU
saltii *(Baker) Oberm., Rennie 608* NU
Kniphofia
baurii *Baker, Rennie 732* NU
brachystachya *(Zahlbr.) Codd, Rennie 486* NU
fibrosa *Baker, Rennie 1316* NU, *1635* PRE
fluviatalis *Codd, Rennie 1862* NU
galpinii *Baker, Rennie 1392* NU
gracilis *Harv. ex Baker, Edwards 1051* NU
ichopensis *Baker ex Schinz, Rennie 675* NU
laxiflora *Kunth, W. Marais 829* PRE
northiae *Baker, Rennie 786* NU
parviflora *Kunth, Rennie 1044* NU; *Edwards 2190* NU
porphyrantha *Baker, Rennie 686* NU
triangularis *Kunth* subsp. triangularis, *W. Marais 830* PRE
sp., *Rennie 1632a, 1634* PRE

Aloe
ecklonis *Salm-Dyck, Rennie 214* NU
ferox *Mill., Rennie 396* NU
maculata *All., Rennie 404* NU

ANTHERICACEAE
Chlorophytum
acutum *(C.H.Wright) Nordal, Feltham 206* NU; *Rennie 1734* PRE [*Anthericum acutum*]
comosum *(Thunb.) Jacq., Rennie 1122* NU
cooperi *(Baker) Nordal, Rennie 787* NU [*Anthericum cooperi*]
krookianum *Zahlbr., Edwards 2052* NU

HYACINTHACEAE
Bowiea volubilis *Harv. ex Hook.f., Rennie 736; Edwards 1934* NU
Albuca
fastigiata *(L.f.) Dryand., Rennie 533* NU
humilis *Baker, Rennie 276* NU
polyphylla *Baker, Rennie 1305* NU
rupestris *Hilliard & B.L.Burtt, Rennie 225* NU
setosa *Jacq., Rennie 1373* NU
xanthocodon *Hilliard & B.L.Burtt, Rennie 35* NU
Urginea
calcarata *(Baker) Hilliard & B.L.Burtt, Rennie 598* NU
capitata *(Hook.) Baker, Rennie 45* NU
macrocentra *Baker, Rennie 1291* NU
multisetosa *Baker, Rennie 137* NU
tenella *Baker, Rennie 1882* NU
Drimia
robusta *Baker, Rennie 44* NU
sphaerocephala *Baker, Rennie 1192* NU
Dipcadi
gracillimum *Baker, Rennie 243* NU
viride *(L.) Moench, Feltham 199* NU
Scilla
natalensis *Planch., Rennie 142* NU
nervosa *(Burch.) Jessop, Rennie 253* NU
Ledebouria
cooperi *(Hook.f.) Jessop, Rennie 80* NU
ovatifolia *(Baker) Jessop, Rennie 78* NU
Eucomis
autumnalis *(Mill.) Chitt.* subsp. clavata *(Baker) Reyneke, Rennie 810* NU
bicolor *Baker, Rennie 742* NU
comosa *(Houtt.) Wehrh.* var. comosa, *Rennie 809* NU
montana *Compton, Rennie s.n.* NU
Ornithogalum
graminifolium *Thunb., Medley Wood 4567* PRE
juncifolium *Jacq., Feltham 182a* NU
paludosum *Baker, Rennie 1102* NU
sp. cf. graminifolium *Thunb., Feltham 177* NU
Drimiopsis lachenalioides *(Baker) Jessop, Rennie 234* NU

ERIOSPERMACEAE
Eriospermum
natalense *Baker, Rennie 1289* NU
ornithogaloides *Baker, Feltham 182* NU
sprengerianum *Schinz, Rennie 1289* NU

AGAPANTHACEAE
Agapanthus campanulatus *Leighton, Feltham 407* NU

ALLIACEAE
Tulbaghia
acutiloba *Harv., Rennie 781* NU
leucantha *Baker, Feltham 187* NU
ludwigiana *Harv., Rennie 842* NU

ASPARAGACEAE
Asparagus
africanus *Lam., Rennie 595* NU [*Protasparagus africanus* (Lam.) Oberm.]
virgatus *Baker, Feltham 355* NU [*Protasparagus virgatus* (Baker) Oberm.]
ramosissimum *Baker, Rennie 716* NU [*Myrsiphyllum ramosissimum* (Baker) Oberm.]

LUZURIAGACEAE
Behnia reticulata *(Thunb.) Didr., Feltham 234* NU

AMARYLLIDACEAE
Haemanthus humilis *Jacq.* subsp. hirsutus *(Baker) Snijman, Rennie 618* NU
Scadoxus puniceus *(L.) Friis & Nordal, Rennie 839* NU

Nerine appendiculata *Baker*, *Feltham 406* NU
Brunsvigia
grandiflora *Lindl.*, *Rennie 925* NU
natalensis *Baker*, *Rennie 808* NU
undulata *F.M.Leight.*, *Rennie 1123* NU
Apodolirion buchananii *Baker*, *Rennie 2551* NU
Cyrtanthus
breviflorus *Harv.*, *Rennie 600* NU
tuckii *Baker*, *Rennie 597* NU

HYPOXIDACEAE
Empodium monophyllum *(Nel) B.L.Burtt*, *Rennie 79* NU
Hypoxis
filiformis *Baker*, *Feltham 169* NU
galpinii *Baker*, *Edwards 2027* NU
gerrardii *Baker*, *Rennie 91* NU
hemerocallidea *Fisch. & C.A.Mey.*, *Rennie 1860 NU*
iridifolia *Baker*, *Rennie 610* NU
lata *Nel*, *Rennie 1841* NU
parvula *Baker* var. parvula, *Feltham 140* NU
Rhodohypoxis
baurii *(Baker) Nel*
var. platypetala *(Baker) Nel*, *Rennie 73* NU
var. platypetala × *R. milloides* (putative hybrid), *Rennie 70* NU
milloides *(Baker) Hilliard & B.L.Burtt*, *Rennie 236* NU

VELLOZIACEAE
Xerophyta viscosa *Baker*, *Rennie 451* NU

DIOSCOREACEAE
Dioscorea
dregeana *(Kunth) T.Durand & Schinz*, *Edwards 1955* NU
rupicola *Kunth*, *Rennie 2526* NU
tysonii *Baker*, *Rennie 1585* NU

IRIDACEAE
Moraea
brevistyla *(Goldblatt) Goldblatt*, *Rennie 1590* NU
carnea *Goldblatt*, *Rennie 1499* NU
hiemalis *Goldblatt*, *Rennie 572* NU
huttonii *(Baker) Oberm.*, *Rennie 836* NU
inclinata *Goldblatt*, *Rennie 893* NU
modesta *Killick*, *Rennie 769* NU
spathulata *(L.f.) Klatt*, *Rennie 1859* NU
stricta *Baker*, *Rennie 749* NU
trifida *R.C.Foster*, *Rennie 1248* NU
unibracteata *Goldblatt*, *Rennie 1348* NU
Dietes iridioides *(L.) Sweet ex Klatt*, *Edwards 2056* NU
Aristea
cognata *N.E.Br. ex Weim.*, *Feltham 49* NU
woodii *N.E.Br.*, *Feltham 420* NU
Hesperantha
baurii *Baker*, *Edwards 1999* NU
glareosa *Hilliard & B.L.Burtt*, *Rennie 1215* NU
grandiflora *G.J.Lewis*, *Rennie 567* NU
hygrophila *Hilliard & B.L.Burtt*, *Rennie 731* NU
tysonii *Baker*, *Rennie 409* NU
vernalis *Hilliard & B.L.Burtt*, *Rennie 751* NU
Dierama
argyreum *L.Bolus*, *Rennie 433* NU
dissimile *Hilliard*, *Rennie 1251* NU
dracomontanum *Hilliard*, *Rennie 1152* NU
galpinii *N.E.Br.*, *Rennie 847* NU
latifolium *N.E.Br.*, *Rennie 971* NU
pauciflorum *N.E.Br.*, *Feltham 23* NU
trichorhizum *(Baker) N.E.Br.*, *Rennie 1146* NU
Tritonia lineata *(Salisb.) Ker Gawl.*, *Rennie 47* NU
Crocosmia
aurea *(Pappe ex Hook.) Planch.*, *Feltham 405* NU
paniculata *(Klatt) Goldblatt*, *Rennie 530* NU
pottsii *(MacNab ex Baker) N.E.Br.*, *Rennie 532* NU
Gladiolus
crassifolius *Baker*, *Rennie 346* NU
dalenii *Van Geel*, *Edwards 2057* NU
ecklonii *Lehm.*, *Rennie 260* NU
longicollis *Baker*, *Rennie 710* NU
oppositiflorus *Herb. Rennie 531* NU [*G. oppositiflorus* Herb. subsp. *salmoneus (Baker) Oberm.*]
papilio *Hook.f.*, *Rennie 264* NU
parvulus *Schltr.*, *Rennie 1158* NU
pubigerus *G.J.Lewis*, *Rennie 1252* NU
pugioniformis *Hilliard & B.L.Burtt*, *Rennie 773* NU
sericiovillosus *Hook.f.*, *Edwards 2014* NU
Watsonia
densiflora *Baker*, *Rennie 1989* NU
lepida *N.E.Br.*, *Rennie 1151* NU
Freesia laxa *(Thunb.) Goldblatt & J.C.Manning* [*Anomatheca laxa* (Thunb.) Goldblatt]

ORCHIDACEAE
Stenoglottis fimbriata *Lindl.*, *Edwards 2053* NU
Holothrix scopularia *(Lindl.) Rchb.f.*, *Rennie 148* NU
Huttonaea
grandiflora *(Schltr.) Rolfe*, *Rennie 1136* NU
oreophila *Schltr.*, *Rennie 1010* NU
pulchra *Harv.*, *Rennie 796* NU
Habenaria
ciliosa *Lindl.*, *Rennie 2502* NU
dives *Rchb.f.*, *Feltham 117* NU
dregeana *Lindl.*, *O'Connor s.n.* NU
epipactidea *Rchb. f.*, *Rennie 903* NU
laevigata *Lindl.*, *Rennie 634* NU
lithophila *Schltr.*, *Rennie 746* NU
pseudociliosa *Schelpe ex J.C.Manning*, *O'Connor s.n.* NU
schimperiana *Hochst. ex A.Rich.*, *Rennie 799* NU
tysonii *Bolus*, *Rennie 1303* NU
Bonatea bracteata *G.J.McDonald & McMurtry*, *Rennie 1301* NU [*B. densiflora* Sond.]
Brachycorythis ovata *Lindl.*, *Rennie 521* NU
Satyrium
bracteatum *(L.f.) Thunb.*, *Rennie 1285* NU
cristatum *Sond.*
var. cristatum *Sond.*, *Feltham 108* NU
var. longilabiatum *A.V.Hall*, *Edwards 2032* NU
hallackii *Bolus* subsp. ocellatum *(Bolus) A.V.Hall*, *Rennie 1084* NU
ligulatum *Lindl.*, *Rennie 314* NU
longicauda *Lindl.*, *Feltham 99* NU
macrophyllum *Lindl.*, *Rennie 371* NU
neglectum *Schltr.*, *Rennie 1298* NU
parviflorum *Sw.*, *Rennie 280* NU
Schizochilus
angustifolius *Rolfe*, *Feltham 109* NU
flexuosus *Harv. ex Rolfe*, *W. Marais 1454* PRE
zeyheri *Sond.*, *Rennie 730* NU
Brownleea
galpinii *Bolus*
subsp. galpinii, *Rennie 348* NU
subsp. major *(Bolus) H.P.Linder*, *Rennie 820* NU
parviflora *Harv. ex Lindl.*, *Rennie 1341* NU
Disa
aconitoides *Sond.*, *Rennie 244* NU
brevicornis *(Lindl.) Bolus*, *Rennie 1087* NU
cephalotes *Rchb. f.*, *Rennie 1304* NU
chrysostachya *Sw.*, *Rennie 725* NU
cooperi *Rchb.f.*, *Feltham 115* NU
crassicornis *Lindl.*, *Rennie 1711* NU
fragrans *Schltr.*, *McClean 229* PRE
oreophila *Bolus*, *Edwards 2004* NU
patula *Sond.* var. transvaalensis *Summerh.*, *Rennie 1834* NU
pulchra *Sond.*, *Rennie 296* NU
rhodantha *Schltr.*, *Rennie 1191* NU
scullyi *Bolus*, *Rennie 1684* NU
stachyoides *Rchb.f.*, *Feltham 110* NU
stricta *Sond.*, *Rennie 1370* NU
thodei *Schltr. ex Kraenzl.*, *Rennie 1190* NU
versicolor *Rchb.f.*, *Rennie 901* NU
Disperis
cardiophora *Harv.*, *Rennie 1197* NU
concinna *Schltr.*, *Rennie 729*
cooperi *Harv.*, A. Rennie's list
fanniniae *Harv.*, *Rennie 537* NU
lindleyana *Rchb.f.*, *Rennie 1768* NU
renibractea *Schltr.*, *Feltham 101* NU
stenoplectron *Rchb.f.*, *Feltham 200* NU
tysonii *Bolus*, *Rennie 831* NU
wealii *Rchb.f.*, *Rennie 729* NU
Pterygodium
cooperi *Rolfe*, *Edwards 1995* NU
leucanthum *Bolus*, *Rennie 888* NU
magnum *Rchb.f.*, *Rennie 798* NU

Corycium
dracomontanum *Parkman & Schelpe*,
nigrescens *Sond.*, *Rennie 295* NU
Liparis bowkeri *Harv.*, *Edwards 1931* NU
Polystachya ottoniana *Rchb.f.*, *Edwards 2023* NU
Eulophia
aculeata *(L.f.) Spreng.* subsp. huttonii *(Rolfe) A.V.Hall*, *Rennie 229* NU
calanthoides *Schltr.*, *Rennie 642* NU
clavicornis *Lindl.*
var. clavicornis, *Rennie 77* NU
var. inaequalis *(Schltr.) A.V.Hall*, *Rennie 1727* NU
var. nutans *(Sond.) A.V.Hall*, *Rennie 622* NU
foliosa *(Lindl.) Bolus*, *Rennie 273* NU
leontoglossa *Rchb.f.*, *Feltham 111* NU
ovalis *Lindl.*, *Rennie 1240* NU
tenella *Rchb.f.*, *Rennie 174* NU
zeyheriana *Sond.*, *Rennie 283* NU
Diaphananthe caffra *(Bolus) H.P.Linder*, *Rennie 1988* NU
Mystacidium
flanaganii *(Bolus) Bolus*, *Rennie 835* NU
gracile *(Rchb.f.) Harv.*, *Rennie 1318* NU
Tridactyle tricuspis *(Bolus) Schltr.*, *Edwards 2024* NU

ANGIOSPERMAE-DICOTYLEDONAE

PIPERACEAE
Peperomia
retusa *(L.f.) A.Dietr.*, *Rennie 1968* PRE
tetraphylla *(G.Forst.) Hook. & Arn.*, *Rennie 110* NU

SALICACEAE
Salix
*babylonica *L.* , *Rennie 1141* NU
mucronata *Thunb.* subsp. woodii *(Seemen) Immelman*, *Edwards 2058* NU

ULMACEAE
Celtis africana *Burm.f.*, *Feltham 224* NU

MORACEAE
Ficus
burtt-davyi *Hutch.*, Cooper's list
natalensis *Hochst.*, Cooper's list

URTICACEAE
Urtica lobulata *Blume*, *Rennie 406* NU
Laportea
alatipes *Hook.f.*, *Edwards 2045* NU
peduncularis *(Wedd.) Chew.*, *Edwards 2206* NU
Droguetia ambigua *Wedd.*, *Edwards 1961* NU

PROTEACEAE
Protea
caffra *Meisn.*, *Rennie 840* NU
roupelliae *Meisn.*, *Rennie 645* NU
simplex *E.Phillips*, *McClean 215* PRE

SANTALACEAE
Osyridicarpos schimperianus *(Hochst. ex A.Rich.) A.DC.*, *Rennie 2499* NU
Thesium
acutissimum *A.DC.*, *Rennie 1562* E
cupressoides *A.W.Hill*, *Feltham 154* NU
imbricatum *Thunb.*, *Rennie 1858* NU
scirpioides *A.W.Hill*, *Rennie 613* NU
zeyheri *A.DC.*, *Rennie 25* NU

POLYGONACEAE
Rumex
acetosella *L.* subsp. angiocarpus *(Murb.) Murb.*, *Rennie 33* NU
*crispus *L.*, *Rennie 1745* NU
sagittatus *Thunb.*, *Rennie 1950* PRE
steudelii *Hochst. ex A.Rich.*, *Rennie 1747* NU
woodii *N.E.Br.*, *Rennie 432* NU
Persicaria
*nepalensis *(Meisn.) H.Gross*, *Rennie 1105* NU
serrulata *(Lag.) Webb & Moq.*, *Rennie 368* NU

CHENOPODIACEAE
Chenopodium
*album *L.*, *Rennie 660* NU
*ambrosioides *L.*, *Rennie 1065* NU

AMARANTHACEAE
*Amaranthus hybridus *L.* subsp. hybridus, *Rennie 1789* NU
Cyathula cylindrica *Moq.*, *Rennie 1625* NU
*Achyranthes aspera *L.* var. sicula *L.* , *Rennie 1618* NU

AIZOACEAE
Psammotropha
mucronata *(Thunb.) Fenzl* var. mucronata, *Crouch 281* NU
myriantha *Sond.*, *Rennie 441* NU

PHYTOLACCACEAE
Phytolacca
heptandra *Retz.*, *Rennie 531* NU
octandra *L.*, *Rennie 97* NU

MESEMBRYANTHEMACEAE
Delosperma
alticolum *L.Bolus*, *Rennie 621* NU
galpinii *L.Bolus*, *Rennie 150* NU
obtusum *L.Bolus*, *Rennie 1024* E

PORTULACACEAE
Portulaca kermesina *N.E.Br.*, *Rennie 1023* NU

CARYOPHYLLACEAE
Cerastium
arabidis *E.Mey. ex Fenzl*, *Rennie 87* NU
capense *Sond.*, *Rennie 849* NU
indicum *Wight & Arn.*, *Rennie 364* NU
Drymaria cordata *(L.) Willd. ex Roem & Schult.* subsp. diandra *(Blume) J.Duke*, *Edwards 1939* NU
Silene
burchellii *Otth*
var. burchellii, *Rennie 883* NU
var. latifolia *Sond.*, *Rennie 1616* NU
pilosellifolia *Cham. & Schltdl.*, *Rennie 445* NU
undulata *Aiton*, *Rennie 476* NU
Dianthus
basuticus *Burtt Davy*, *Rennie 1890* NU
mooiensis *F.N.Williams*, *Rennie* 452 NU

RANUNCULACEAE
Anemone caffra *Eckl. & Zeyh.*, *Hilliard & Burtt 7169* NU
Clematis brachiata *Thunb.*, *Rennie 927* NU
Ranunculus
baurii *Macowan*, *Rennie 484* NU
meyeri *Harv.*, *Rennie 111* NU
multifidus *Forssk.*, *Hilliard & Burtt 7171* NU
Thalictrum rhynchocarpum *Quart.-Dill. & Rich.*, *Feltham 78* NU

MENISPERMACEAE
Cissampelos torulosa *E.Mey. ex Harv.*, *Edwards 1949* NU

TRIMENIACEAE
Xymalos monospora *(Harv.) Baill.*, *Edwards 1941* NU

LAURACEAE
Ocotea bullata *(Burch.) Baill.*, *Edwards 2059* NU
Cryptocarya
myrtifolia *Stapf*, Cooper's list
woodii *Engl.*, *Feltham 221* NU

PAPAVERACEAE
*Argemone mexicana *L.*, *Rennie 1730* NU
Papaver aculeatum *Thunb.*, *Rennie 877* NU

FUMARIACEAE
Cysticapnos pruinosa *(Bernh.) Lidén*, *Rennie 1660* NU

BRASSICACEAE
Heliophila rigidiuscula *Sond.*, *Rennie 1186* NU
Lepidium schinzii *Thell.*, *Hilliard & Burtt 7587* NU
Sisymbrium capense *Thunb.*, *Rennie 717* NU
Cardamine
africana *L.*, *Rennie 1050* NU
*impatiens *L.*, *Rennie 785* NU

CAPPARACEAE
Cleome monophylla *L.*, *Rennie 1722* NU

DROSERACEAE
Drosera natalensis *Diels*, *Rennie 640* NU

CRASSULACEAE
Kalanchoe thyrsiflora *Harv.*, *Rennie 403* NU
Crassula
dependens *Bolus*, *Rennie 277* NU
lanceolata *(Eckl. & Zeyh.) Endl. ex Walp.* subsp. lanceolata, *Rennie 1610* NU
natalensis *Schönland*, *Rennie 390* NU
natans *Thunb.*

Crassula (cont.)
nudicaulis *L., Rennie 90* NU
pellucida *L.*
subsp. alsinoides *(Hook.f.) Toelken, Hilliard & Burtt 7609* NU
subsp. brachypetala *(Drège ex Harv.) Toelken, Rennie 323* NU
sarcocaulis *Eckl. & Zeyh.* subsp. rupicola *Toelken, Rennie 1115* NU
setulosa *Harv.*
var. rubra *(N.E.Br.) G.D.Rowley, Rennie 816* NU
var. setulosa, *Vos 45* NU
umbraticola *N.E.Br., Feltham 58* NU
vaginata *Eckl. & Zeyh.* subsp. vaginata, *Rennie 575* NU

PITTOSPORACEAE
Pittosporum viridiflorum *Sims, Rennie 2463* NU

HAMAMELIDACEAE
Trichocladus ellipticus *Eckl. & Zeyh.*, Cooper's list

ROSACEAE
Rubus
ludwigii *Eckl. & Zeyh., Rennie 790* NU
*rigidus *Sm., Rennie 1071*
*Duchesnea indica *(Andrews) Focke, Rennie 118* NU
Geum capense *Thunb., Rennie 152* NU
Alchemilla
natalensis *Engl., Rennie 1210* NU
woodii Kuntze, *Hilliard & Burtt 7210* PRE
Agrimonia procera *Wallr., Rennie 176* NU
Leucosidea sericea *Eckl. & Zeyh., Feltham 268* NU
Cliffortia
linearifolia *Eckl. & Zeyh., Rennie 120* NU
nitidula *(Engl.) R.E.Fr. & Th.Fr.* subsp. pilosa *Weim., Feltham 155* NU
Prunus africanus *(Hook.f.) Kalkm., Edwards 2230* NU

FABACEAE
Acacia
ataxacantha *DC., Edwards 2218* NU
*melanoxylon *R.Br., Feltham 212* NU
Hoffmanseggia sandersonii *(Harv.) Engl., Hilliard & Burtt 7182* NU
Calpurnia
aurea *(Aiton) Benth.* subsp. aurea, *Feltham 244* NU
sericea *Harv., Rennie 255* NU
Lotononis
carnosa *(Eckl. & Zeyh.) Benth., Rennie 1184* NU
corymbosa *(E.Mey.) Benth., Feltham 133* NU
eriantha *Benth., Rennie 1423* NU
eriocarpa *(E.Mey.) B.-E.van Wyk, Rennie 291* NU [*L. biflora* (Bolus) Dummer]
foliosa *Bolus, Hilliard & B.L.Burtt 421* NU
laxa *Eckl. & Zeyh., Rennie 1025* NU
lotononoides *(Scott Elliot) B.-E.van Wyk, Rennie 709* NU
pulchella *(E.Mey.) B.-E.van Wyk, Rennie 1508* PRE
pulchra *Dummer, Rennie 1507* PRE
viminea *(E.Mey.) B.-E.van Wyk, Rennie 1509* PRE
virgata *B.-E.van Wyk, Rennie 1056* NU
Pearsonia grandifolia *(Bolus) Polhill, Feltham 354* NU
Melolobium
alpinum *Eckl. & Zeyh., Rennie 1271* NU
microphyllum *(L.f.) Eckl. & Zeyh., Rennie 747* NU
obcordatum *Harv., Rennie 247* NU
Argyrolobium
amplexicaule *Dummer, Edwards 2217* NU
nigrescens *Dummer, Edwards 1055* NU
rupestre *(E.Mey.) Walp., Edwards 1091* NU
sericosemium *Harms, Edwards 1092* NU
tomentosum *(Andrews) Druce, Rennie 245* NU
tuberosum *Eckl. & Zeyh., Feltham 421* NU
Medicago laciniata *(L.) Mill., Rennie 981* NU
Trifolium burchellianum *Ser., Rennie 327* NU
Indigofera
cuneifolia *Eckl. & Zeyh.*,
dregeana *E.Mey., Rennie 458* NU
fastigiata *E.Mey., Rennie 448* NU
foliosa *E.Mey., Rennie 977* NU
hedyantha *Eckl. & Zeyh., Rennie 293* NU
hilaris *Eckl. & Zeyh., Rennie 270* NU
longebarbata *Engl., Rennie 1247* NU
trifolioides *Baker f., Rennie 1732* PRE
woodii *Bolus, Edwards 1058* NU
Psoralea rhizotoma *C.H.Stirt., Rennie 282* NU

Tephrosia
macropoda *(E.Mey.) Harv.* var. diffusa *(E.Mey.) Schrire, Rennie 1104* NU
marginella *H.M.L.Forbes, Rennie 910* NU
polystachya *E.Mey., Rennie 513* NU
Sutherlandia montana *E.Phillips & R.A.Dyer, Rennie 1372* NU
Dalbergia obovata *E.Mey.*, Cooper's list
Lessertia perennans *(Jacq.) DC.* var. perennans, *Rennie 419* NU
Zornia capensis *Pers., Rennie 496* NU
Desmodium repandum *(Vahl) DC., Edwards 1944* NU
Dumasia villosa *DC., Edwards 2043* NU
Rhynchosia
caribaea *(Jacq.) DC., Vos 48* NU
pentheri *Schltr., Rennie 1129* NU
reptabunda *N.E.Br., Rennie 246* NU
totta *(Thunb.) DC., Rennie 989* NU
Eriosema
distinctum *N.E.Br., Feltham 134* NU
kraussianum *Meisn., Rennie 114* NU
salignum *E.Mey., Rennie 1319* NU
squarrosum *Walp. Edwards 2232* NU
Vigna
nervosa *Markötter, Vos 36* NU
vexillata *(L.) A.Rich, Rennie 1858* NU
Dolichos angustissimus *E.Mey., Rennie 769* NU

GERANIACEAE
Geranium
flanaganii *Knuth, Vos 61* NU
pulchrum *N.E.Br., Feltham 402* NU
schlechteri *Knuth, Rennie 1525* PRE
wakkerstroomianum *Knuth, Rennie 466* NU
Monsonia
brevirostrata *Knuth, Rennie 1331* NU
grandifolia *Knuth, Rennie 792* PRE
Pelargonium
alchemilloides *(L.) L'Hér., Vos 37* NU
bowkeri *Harv., Rennie 1865* NU
luridum *(Andrews) Sweet, Rennie 738* NU
multicaule *Jacq., Rennie 394* NU
schlechteri *Knuth, Rennie 1822* NU
zonale *(L.) L'Hér., Rennie 772* NU

OXALIDACEAE
Oxalis
*corniculata *L., A. Rennie s.n.* NU
obliquifolia *Steud. ex A.Rich, Rennie 995* NU
semiloba *Sond., Rennie 1284* NU

LINACEAE
Linum thunbergii *Eckl. & Zeyh., Rennie 1212* NU

RUTACEAE
Zanthoxylon
capense *(Thunb.) Harv.*, Cooper's list
davyi *(I.Verd.) P.G.Waterman, Feltham 226* NU
Calodendrum capense *(L.f.) Thunb.*, Cooper's list
Vepris lanceolata *(Lam.) G.Don, Feltham 245* NU
Clausena anisata *(Willd.) Hook.f. ex Benth., Rennie 714* NU

PTAEROXYLACEAE
Ptaeroxylon obliquum *(Thunb.) Radlk., Edwards 2211* NU

MELIACEAE
Ekebergia capensis *Sparrm., Edwards 2016* NU

POLYGALACEAE
Polygala
gerrardii *Chodat, Rennie 286* NU
gracilenta *Burtt Davy, Edwards 1066* NU
hottentotta *C.Presl, Rennie 1614* NU
macowaniana *Paiva, Feltham 131* NU [*P. confusa* MacOwan]
ohlendorfiana *Eckl. & Zeyh., Feltham 136* NU
refracta *DC., Rennie 1448* NU
rehmannii *Chodat, Rennie 1868* NU
rhinostigma *Chodat, Rennie 1591* NU
virgata *Thunb., Rennie 377* NU
Muraltia flanaganii *Bolus, Nicholas 1145* NU

EUPHORBIACEAE
Micrococca capensis *(Baill.) Prain, Edwards s.n.* NU
Adenocline
acuta *(Thunb.) Baill., Edwards 2192* NU
pauciflora *Turcz., Rennie 697* NU

Acalypha
peduncularis *E.Mey. ex Meisn., Rennie 115* NU
punctata *Meisn., Feltham 207* NU
schinzii *Pax, Edwards 2035* NU
Clutia
abyssinica *Jaub. & Spach, Scott-Shaw 3333* CPF
katherinae *Pax, Rennie 123* NU
laxa *Eckl. ex Sond., Rennie 147* NU
pulchella *L.*
var. franksiae *Prain, Rennie 1667* NU
var. obtusata *Sond., Rennie 1030* NU
var. pulchella *Sond., Feltham 341* NU
Euphorbia
clavarioides *Boiss., Rennie 1017* NU
epicyparissias *E.Mey. ex Boiss., Feltham 197* NU
gueinzii *Boiss., Rennie 144* NU
kraussiana *Bernh.* var. erubescens *N.E.Br., Rennie 1847* PRE
natalensis *Bernh., Rennie 1157* NU
striata *Thunb., Rennie 26* NU
Chamaesyce inaequilatera *(Sond.) Soják, Rennie 654* NU

ANACARDIACEAE
Protorhus longifolia *(Bernh.) Engl.*, Scott-Shaw's list
Rhus
chiridensis *Baker f., Edwards s.n.* NU
dentata *Thunb., Feltham 264* NU
discolor *E.Mey. ex Sond., Feltham 127* NU
pyroides *Burch.*
var. pyroides, *Rennie 1032* NU
var. gracilis *(Engl.) Burtt Davy, Feltham 261* NU
tomentosa *L., Edwards 1998* NU
montana *Diels, Edwards 1986* NU

AQUIFOLIACEAE
Ilex mitis *(L.) Radlk.* var. mitis, *Edwards 2212* NU

CELASTRACEAE
Gymnosporia
heterophylla *(Eckl. & Zeyh.) Loes., Feltham 263* NU [*Maytenus heterophylla* (Eckl. & Zeyh.) N. Robson]
mossambicensis *(Klotzsch) Loes., Feltham 255* NU [*Maytenus mossambicensis* (Klotzsch) Blakelock]
uniflora *Davison, Edwards 2000* NU
Maytenus
acuminata *(L.f.) Loes., Feltham 210* NU
peduncularis *(Sond.) Loes, Scott-Shaw 3324* CPF
undata *(Thunb.) Blakelock, Scott-Shaw 3315* CPF
Pterocelastrus
echinatus *N.E.Br.*,
rostratus *Walp.*,
Lauridia tetragona *(L.f.) R.H.Archer., Edwards 1951* NU [*Cassine tetragona* (L.f.) Loes.]
Hippocratea schlechteri *Loes., Scott-Shaw 3341* CPF

ICACINACEAE
Cassinopsis ilicifolia *(Hochst.) Kuntze, Feltham 278* NU
Apodytes dimidiata *E.Mey. ex Arn.* subsp. dimidiata, *Scott-Shaw 3314* CPF

SAPINDACEAE
Allophyllus
africanus *P.Beauv., Feltham 258* NU
dregeanus *(Sond.) De Winter, Feltham 254* NU

MELIANTHACEAE
Bersama tysoniana *Oliv.*, Scott-Shaw's list

GREYIACEAE
Greyia sutherlandii *Hook. & Harv., Rennie 1148* NU

BALSAMINACEAE
Impatiens hochstetteri *Warb.* subsp. hochstetteri, *Feltham 193* NU

RHAMNACEAE
Scutia myrtina *(Burm.f.) Kurz, Edwards 1984* NU
Rhamnus prinoides *L'Hér., Feltham 217* NU
Phylica paniculata *Willd., Edwards 2007* NU

VITACEAE
Rhoicissus
revoilii *Planch., Edwards 1957* NU
tomentosa *(Lam.) Wild & R.B.Drumm.*, Cooper's list
tridentata *(L.f.) Wild & R.B.Drumm., Rennie 790* NU

TILIACEAE
Grewia
lasiocarpa *E.Mey. ex Harv.*, Cooper's list
occidentalis *L., Rennie 733* NU

MALVACEAE
Anisodontea julii *(Burch. ex DC.) Bates* subsp. pannosa *(Bolus) Bates, Rennie 1061* NU
*Malva neglecta *Wallr., Rennie 1292* NU
Hibiscus
aethiopicus *L., Rennie 723* NU
saxatilis *J.M.Wood & M.S.Evans, Rennie 1273* NU
trionum *L., Rennie 1126* NU

STERCULIACEAE
Dombeya
cymosa *Harv., Feltham 275* NU
tiliacea *(Endl.) Planch.*, Scott-Shaw's list
Hermannia
cristata *Bolus, Hilliard & B.L.Burtt 7181* NU
gerrardii *Harv., Rennie 75* NU
woodii *Schinz, Rennie 164* NU

OCHNACEAE
Ochna
gamostigmata *Du Toit, Rennie 468* NU
serrulata *(Hochst.) Walp., Rennie 995* NU

CLUSIACEAE
Hypericum
aethiopicum *Thunb., Feltham 57* NU
lalandii *Choisy, Rennie 1564* NU
natalense *J.M.Wood & M.S.Evans, Rennie 976* NU

VIOLACEAE
Hybanthus
capensis *(Thunb.) Engl., Burtt & Hilliard 3494* NU
parviflorus *(L.f.) Baill., Edwards 2215* NU

FLACOURTIACEAE
Kiggelaria africana *L., Rennie 1258* NU
Scolopia
flanaganii *(Bolus) Sim, Scott-Shaw 3317* CPF
mundii *(Eckl. & Zeyh.) Warb., Rennie 231* NU
zeyheri *(Nees) Harv., Edwards 2036* NU
Trimeria grandifolia *(Hochst.) Warb., Rennie 620* NU; *Feltham 230* NU
Dovyalis
lucida *Sim, Rennie 997* NU
rhamnoides *(Burch. ex DC.) Harv., Edwards 2214* NU
zeyheri *(Sond.) Warb., Scott-Shaw 3332* CPF
Casearia gladiiformis *Mast.*, Scott-Shaw's list

ACHARIACEAE
Ceratiosicyos laevis *(Thunb.) A.Meeuse, Rennie 832, Edwards 1940* NU

BEGONIACEAE
Begonia sutherlandii *Hook.f., W. Marais 1448* PRE

OLINIACEAE
Olinia emarginata *Burtt Davy, Rennie 469* NU

THYMELAEACEAE
Peddiea africana *Harv.*, Scott-Shaw's list
Gnidia
baurii *C.H.Wright, Rennie 1490* NU
caffra *(Meisn.) Gilg, Rennie 135* NU
gymnostachya *(C.A.Mey.) Gilg, Rennie 223* NU
kraussiana *Meisn.* var. kraussiana, *Feltham 84* NU
phaeotricha *Gilg, Rennie 1274* NU
polyantha *Gilg, Rennie 36* NU
renniana *Hilliard & B.L.Burtt, Feltham 57* NU
Passerina
filiformis *L., Rennie 82* NU
montana *Thoday, Edwards 1125* NU
Dais cotonifolia *L., Rennie 1047* NU

RHIZOPHORACEAE
Cassipourea gerrardii *(Schinz) Alston*, Scott-Shaw's list CPF

COMBRETACEAE
Combretum
edwardsii *Exell, Edwards 1977* NU
kraussii *Hochst., Rennie 1967* NU

MYRTACEAE
Eugenia zuluensis *Dummer, Feltham 248* NU
Syzygium gerrardii *(Harv. ex Hook.f.) Burtt Davy*, Cooper's list

ONAGRACEAE
Epilobium
capense *Buchinger ex Hochst., Rennie 438* NU

Epilobium
hirsutum *L.*, *Rennie 583* NU
salignum *Hausskn.*, *Rennie 389* NU
*Oenothera rosea *L'Hér. ex Aiton*, *Rennie 34* NU

HALORAGACEAE
Gunnera perpensa *L.*, *Rennie 474* NU
Laurembergia repens *P.J.Bergius*, *Huntley 434* NU

ARALIACEAE
Cussonia
paniculata *Eckl. & Zeyh.* subsp. sinuata *(Reyneke & Kok) De Winter*, *McClean 216* PRE
spicata *Thunb.*, *Feltham 252* NU
Seemannaralia gerrardii *(Seem.) Harms*, *Feltham 262* NU

APIACEAE
Sanicula elata *Buch.-Ham. ex D.Don*, *Rennie 1294* NU
Alepidea
amatymbica *Eckl. & Zeyh.*, *Edwards 1044* NU
natalensis *J.M.Wood & M.S.Evans*, *Edwards 1043* NU
woodii *Oliv.*, *Rennie 1076; Edwards 2021* NU
*Anthriscus sylvestris *(L.) Hoffm.*, *Rennie 1281* NU
Conium fontanum *Hilliard & B.L.Burtt* var. fontanum, *Rennie 967* NU
Heteromorpha
arborescens (*Spreng.*) *Cham. & Schltdl.*, *Rennie 872* NU
var. abyssinica (A.Rich.) H.Wolff, *Feltham 256* NU [*H. trifoliata* (H.Wendl.) Eckl. & Zeyh.]
Bupleurum mundii *Cham. & Schltdl.*, *Rennie 379* NU
*Ammi majus *L.* var. glaucifolium *(L.) Godr.*, *Hilliard & Burtt 7600* NU
Pimpinella caffra (*Eckl. & Zeyh.*) *D.Dietr.*, *Rennie 743* NU
Peucedanum
caffrum *(Meisn.) E.Phillips*, *Rennie 418* NU
thodei *Arnold*, *Rennie 540* NU
*Daucus carota *L.*, *Rennie 372* NU

CORNACEAE
Curtisia dentata *(Burm.f.) C.A.Sm.*, *Edwards 1974* NU

ERICACEAE
Erica
algida *Bolus*, *Rennie 1078* NU, *1573* PRE
alopecurus *Harv.*, *Rennie 20* NU
caffrorum *Bolus* var. caffrorum, *Rennie 1574* PRE
cerinthoides *L.*, *Rennie 1375* NU
cooperi Bolus, *Edwards 2049* NU
drakensbergensis *Guthrie & Bolus*, *Rennie 3* NU
evansii *(N.E.Br.) E.G.H.Oliv.*, *Rennie 1066* NU
natalitia *Bolus*, *Edwards 2048* NU
oatesii *Rolfe*, *Rennie 401* NU
woodii *Bolus*
subsp. platyura *Hilliard & B.L.Burtt*, *Rennie 1249* NU
subsp. woodii, *Rennie 529* NU

MYRSINACEAE
Maesa lanceolata *Forssk.*, *Edwards s.n.* NU
Myrsine africana *L.*, *Rennie 342* NU
Rapanea melanophloeos *(L.) Mez*, *Feltham 250* NU

PRIMULACEAE
Lysimachia ruhmeriana *Vatke*, *Rennie 735* NU
Anagallis huttonii *Harv.*, *Rennie 440* NU

EBENACEAE
Euclea crispa (*Thunb.*) *Gürke* subsp. crispa, *Edwards 2012* NU
Diospyros
austro-africana *De Winter* var. rubriflora *(De Winter) De Winter*, *Rennie 594* NU
dichrophylla *(Gand.) De Winter*, *Scott-Shaw 3344* CPF
lycioides *Desf.*, *Rennie 384* NU
whyteana (*Hiern*) *F.White*, *Rennie 508* NU

OLEACEAE
Chionanthus
foveolatus *(E.Mey.) Stearn*, *Scott-Shaw 3311* CPF
peglerae *(C.H.Wright) Stearn*, Scott-Shaw's list
Olea
capensis *L.* subsp. macrocarpa *(C.H.Wright) I.Verd.*, Scott-Shaw's list
europaea L. subsp. africana *(Mill.) P.S.Green*, *Edwards 1947* NU

BUDDLEJACEAE/LOGANIACEAE
Gomphostigma virgatum *(L.f.) Baill.*, *Rennie 644a* NU
Buddleja
auriculata *Benth.*, *Edwards 1952* NU
dysophylla *(Benth.) Radlk.*, *Edwards 2216* NU
loricata *Leeuwenb.*, *Rennie 1491 NU*
salviifolia *(L.) Lam.*, *Feltham 238* NU

GENTIANACEAE
Sebaea
erosa *Schinz*, *Rennie 1973* NU
filiformis *Schinz*, *Rennie 376* NU
longicaulis *Schinz*, *Rennie 1637* NU
repens *Schinz*, *Rennie 399* NU
sedoides *Gilg*
var. confertiflora *(Schinz) Marais*, *Rennie 1638* PRE
var. schoenlandii *(Schinz) Marais*, *Rennie 1640* NU
var. sedoides, *Feltham 201* NU
Chironia
krebsii *Griseb.*, *Feltham 281* NU
peglerae *Prain*, *Rennie 1299* NU

APOCYNACEAE
Carissa bispinosa *(L.) Desf. ex Brenan*, *Rennie 623* NU
Strophanthus speciosus *(Ward & Harv.) Reber*, *Feltham 249* NU
Raphionacme hirsuta *(E.Mey.) R.A.Dyer ex E.Phillips*, *Rennie 1445* NU [*Periplocaceae*]
Xysmalobium [*Asclepiadaceae*]
involucratum *(E.Mey.) Decne.*, *Rennie 897* NU
parviflorum *Harv. ex Scott Elliot*, *Rennie 215* NU
prunelloides *Turcz.*, *Rennie 232* NU
stockenstromense *Scott Elliot*, *Rennie 666* NU
undulatum *(L.) Aiton f.*, *Rennie 536* NU
Schizoglossum
atropurpureum *E.Mey.* subsp. atropurpureum , *Rennie 713* NU
bidens *E.Mey.* subsp. pachyglossum *(Schltr.) Kupicha*, *Rennie 890*; *Edwards 2030* NU
elingue *N.E.Br.* subsp. elingue, *Rennie 233* NU
flavum *Schltr.*, *Feltham 30* NU
hilliardiae *Kupicha*, *Edwards 2225* NU
nitidum *Schltr.*, *Rennie 1325* NU
aff. stenoglossum *Schltr.*, *Edwards 2222* NU
Aspidoglossum
gracile *(E.Mey.) Kupicha*, *Edwards 2220* NU
interruptum *(E.Mey.) Bullock*, *Rennie 1420* NU
Miraglossum
pulchellum *(Schltr.) Kupicha*, *Rennie 297* NU
verticillare *(Schltr.) Kupicha*, *Rennie 892* NU
Periglossum angustifolium *Decne.*, *Hilliard & Burtt 7594* NU
Pachycarpus
campanulatus *(Harv.) N.E.Br.*, *Rennie 898* NU
var. campanulatus, *Rennie 281* NU
dealbatus *E.Mey.*, *Edwards 2189* NU
macrochilus (*Schltr.*) *N.E.Br.*, *Rennie 860* NU
plicatus *N.E.Br.*, *Rennie 311* NU
Asclepias
affinis *(Schltr.) Schltr.*, *Rennie 1179* NU
cultriformis *Harv. ex Schltr.*, *Rennie 864* NU
dregeana *Schltr.*, *Rennie 284* NU
flexuosa *(E.Mey.) Schltr.*, *Rennie 1180* NU
gibba *(E.Mey.) Schltr.*, *Hilliard & Burtt 7205* NU
macropus *(Schltr.) Schltr.*, *Rennie 1120* NU
multicaulis *(E.Mey.) Schltr.*, *Rennie 778* NU
stellifera *Schltr.*, *Rennie 593* NU
Gomphocarpus fruticosus *(L.) Aiton*, *Rennie 284* NU [*Asclepias fruticosa* L.]
Aspidonepsis
diploglossa *(Turcz.) Nicholas & Goyder*, *Rennie 488* NU
flava *(N.E.Br.) Nicholas & Goyder*, *Rennie 275* NU
reenensis *(N.E.Br.) Nicholas & Goyder*, *Rennie 1109* NU
Secamone alpini *Schultes*, *Rennie 950* NU
Brachystelma
pulchellum *(Harv.) Schltr.*, *Rennie 506* NU
Brachystelma (cont.)
pygmaeum *(Schltr.) N.E.Br.*, *Rennie 21* NU
Riocreuxia torulosa *Decne.*, *Rennie 637* NU

CONVOLVULACEAE
Convolvulus natalensis *Bernh. ex Krauss*, *Rennie 617* NU
Ipomoea pellita *Hallier f.*, *Rennie 306* NU

BORAGINACEAE
Cynoglossum
austroafricanum *Hilliard & B.L.Burtt*, *Rennie 379* NU
hispidum *Thunb.*, *Rennie 166* NU
lanceolatum *Forssk.*, *Rennie 545* NU

Cynoglossum (cont.)
spelaeum *Hilliard & B.L.Burtt*, *Rennie 507* NU
Afrotysonia glochidiata *(R.R.Mill) R.R.Mill*, *Rennie 718* NU
Myosotis
semiamplexicaulis *DC.*, *Rennie 825* NU
sylvatica *Hoffm.*, *Feltham 186* NU
Lithospermum
afromontanum *Weim.*, *Rennie 7946* NU
papillosum *Thunb.*, *Rennie 110* NU

VERBENACEAE
Verbena
*bonariensis *L.*, *Rennie 656* NU
*venosa *Gill & Hook.*, *Rennie 664* NU
Lantana rugosa *Thunb.*, *Rennie 1374* NU
Clerodendrum glabrum *E.Mey.*, *Edwards s.n.* NU

LAMIACEAE
Ajuga ophrydis *Burch. ex Benth.*, *Rennie 447* NU
Teucrium kraussii *Codd*, *Rennie 1615* NU
Leonotis
leonurus *(L.) R.Br.*, *Vos 538* NU
obovata *Spreng.*, *Feltham 345* NU
ocymifolia *(Burm.f.) Iwarsson*
var. ocymifolia, *Feltham 345* NU [*L. dubia* E.Mey]
var. raineriana *(Vis.) Iwarsson*, *Vos 44* NU [*L. intermedia* Lindl.]
Stachys
aethiopica *L.*, *Rennie 320* NU
caffra *E.Mey. ex Benth.*, *Feltham 189* NU
grandifolia *E.Mey. ex Benth.*, *Vos 43* NU
kuntzei *Gürke*, *Marais 1450* PRE
sessilis *Gürke*, *Rennie 659* NU
simplex *Schltr.*, *Rennie 1219* NU
Salvia
aurita *L.f.* var. galpinii *(Skan) Hedge*, *Rennie 522* NU
repens *Burch. ex Benth.*, *Edwards 1063* NU
Satureja reptans *Killick*, *Rennie 574* NU
Mentha
aquatica *L.*, *Rennie 819* NU
longifolia *(L.) L.*, *Rennie 999* NU
Pycnostachys reticulata *(E.Mey.) Benth.*, *Rennie 482* NU
Plectranthus
ciliatus *E.Mey. ex Benth.*, *Carbutt s.n.* NU
dolicopodus *Briq.*, *Edwards 1945* NU
fructicosus *L'Hér.*, *Vos 42* NU
grallatus *Briq.*, *Rennie 511* NU
Rabdosiella calycina *(Benth.) Codd*, *Rennie 568* NU
Hemizygia cinerea *Codd*, *Edwards 1977* NU
Becium obovatum *(E.Mey. ex Benth.) N.E.Br.* subsp. obovatum var. obovatum, *Edwards s.n.* NU [*B. grandiflorum* (Lam.) Pic. Serm. var. *obovatum* (E.Mey. ex Benth.) Sebald]

SOLANACEAE
Solanum
chenopodioides *Lam.*, *Rennie 867* NU
giganteum *Jacq.*, *Edwards 1954* NU
*nigrum *L.*, *Edwards 1077* a NU
retroflexum *Dun.*, *Rennie 669* NU

SCROPHULARIACEAE
Diascia megathura *Hilliard & B.L.Burtt*, *Rennie 1735* NU
Nemesia
albiflora *N.E.Br.*, *Rennie 1861* NU
caerulea *Hiern*, *Feltham 47* NU
melissifolia *Benth.*, *Vos 49* NU
silvatica *Hilliard*, *Rennie 1* NU
Diclis
reptans *Benth.*, *Hilliard & Burtt 7192* NU
rotundifolia *(Hiern) Hilliard & B.L.Burtt*, *Hilliard & Burtt 7602* NU
Halleria lucida *L.*, *Rennie 173* NU
Phygelius aequalis *Harv. ex Hiern*, *Rennie 321* NU
Bowkeria verticillata *(Eckl. & Zeyh.) Schinz*, *Rennie 483* NU
Manulea florifera *Hilliard & B.L.Burtt*, *Rennie 302* NU
Sutera
floribunda *(Benth.) Kuntze*, *Edwards 1071* NU
polelensis *Hiern*, *Rennie 1647* NU
Jamesbrittenia
breviflora *(Schltr.) Hilliard*. *Hilliard & Burtt 3471* NU [*Sutera breviflora* (Schltr.) Hiern]
filicaulis *(Benth.) Hilliard*, *Rennie 310* NU [*Sutera filicaulis* (Benth.) Hilliard]

Zaluzianskya
distans *Hiern*, *Rennie 1280* NU
elongata *Hilliard & B.L.Burtt*, *Rennie 1245* NU
glareosa *Hilliard & B.L.Burtt*, *Rennie 1839* PRE
microsiphon *(Kuntze) K.Schum.*, *Edwards 1080* NU
natalensis *Hochst.*, *Rennie 1840* NU
pulvinata *Killick*, *Hilliard & Burtt 7172* NU
spathacea *(Benth.) Walp.*, *Rennie 1244* NU
Mimulus gracilis *R.Br.*, *Rennie 146* NU
Limosella
longiflora *Kuntze*, *Rennie 489* NU
maior *Diels*, *Rennie 23* NU
*Veronica persica *Poir.*, *Rennie 1092* NU
Melasma scabrum *P.J.Bergius*, *Feltham 283* NU
Alectra sessiliflora (*Vahl) Kuntze* var. sessiliflora, *Rennie 1663* NU
Graderia scabra *(L.f.) Benth.*, *Rennie 84* NU
Sopubia cana *Harv.*, *Rennie 639* NU
Buchnera
dura *Benth.*, *Rennie 1228* NU
glabrata *Benth.*, *Rennie 480* NU
simplex *(Thunb.) Druce*, *Rennie 1228* NU
Cycnium racemosum *Benth.*, *Rennie 1237* NU
Striga
asiatica *(L.) Kuntze*, *Rennie 573* NU
bilabiata *(Thunb.) Kuntze*, *Edwards 1061* NU
elegans *Benth.*, *Vos 34* NU
Harveya
pulchra *Hilliard & B.L.Burtt*, *Rennie 2416* NU
speciosa *Benth. ex C.Krauss*, *Rennie 312* NU
Hebenstretia dura *Choisy*, *Feltham 209* NU
Selago
flanaganii *Rolfe*, *Rennie s.n.* NU
immersa *Rolfe*, *Rennie 1293* NU
pachypoda *Rolfe*, *Rennie 318* NU
Walafrida densiflora *(Rolfe) Rolfe*, *Rennie 1669* NU

GESNERIACEAE
Streptocarpus
gardenii *Hook.*, *Rennie 490* NU
pentherianus *Fritsch*, *Feltham 96* NU
pusillus *Harv. ex C.B.Clarke*, *Rennie 424* NU

LENTIBULARIACEAE
Utricularia
livida *E.Mey.*, *Rennie 439* NU
prehensilis *E.Mey.*, *Rennie 16* NU

ACANTHACEAE
Thunbergia venosa *C.B.Clarke*, *Rennie 1270* NU
Chaetacanthus setiger *(Pers.) Lindl.*, *Rennie 1175* PRE
Crabbea acaulis *N.E.Br.*, *Rennie 1062* NU
Hypoestes triflora *(Forssk.) Roem. & Schult.*, *Rennie 1970*
Isoglossa
grantii *C.B.Clarke*, *Rennie 1111*
hypoestiflora *Lindau*, *Feltham 72* NU
macowanii *C.B.Clarke*, *Rennie 1952* NU
Justicia campylostemon *(Nees) T.Anderson*, *Rennie 1990*
Adhatoda andromeda *(Lindau) C.B.Clarke*, *Rennie 66* NU

PLANTAGINACEAE
Plantago
*lanceolata *L.*, *Rennie 1028* NU
*virginica *L.*, *Rennie 1324* NU

RUBIACEAE
Kohautia amatymbica *Eckl. & Zeyh.*, *Rennie 607* NU
Conostomium natalense *(Hochst.) Bremek.*, *Edwards 2011* NU
Burchellia bubalina *(L.f.) Sims*, Scott-Shaw's list
Rothmannia
capensis *Thunb.*, *Edwards 2207* NU
globosa *(Hochst.) Keay*, Scott-Shaw's list
Hyperacanthus amoenus *(Sims) Bridson*,
Tricalysia lanceolata *(Sond.) Burtt Davy*, Scott-Shaw's list
Pentanisia prunelloides *(Klotzsch ex Eckl. & Zeyh.) Walp.*, *Rennie 983* NU
Pygmaeothamnus chamaedendrum *(Kuntze) Robyns*, *Rennie 869* NU
Canthium
ciliatum *(Klotzsch) Kuntze*, *Rennie 1267* NU
kuntzeanum *Bridson*, *Rennie 1033* NU
mundianum *Cham. & Schltd.*, Scott-Shaw's list
Psydrax obovata *(Eckl. & Zeyh.) Bridson* subsp. obovata, Scott-Shaw's list
Pachystigma macrocalyx *(Sond.) Robyns*, *Edwards 1937* NU
Pavetta
cooperi *Harv. & Sond.*, *Edwards 2204* NU

Pavetta (cont.)
kotzei *Bremer*, *Scott-Shaw 3323* CPF
Galopina circaeoides *Thunb.*, *Rennie 1393* NU
Anthospermum herbaceum *L.f.*, *Feltham 71* NU
Spermacoce natalensis *Hochst.*, *Rennie 560* NU
Galium
capense *Thunb.*, *Rennie 268* NU
thunbergianum *Eckl. & Zeyh.*
var. hirsutum *(Sond.) Verdc.*, *Rennie 502* NU
var. thunbergianum, *Rennie 1611* NU
Rubia
petiolaris *DC.*, *Rennie 795* NU
cordifolia *L.* subsp. conotricha *(Gand.) Verdc.*, *Edwards 1973* NU

VALERIANACEAE
Valeriana capensis *Thunb.* var. capensis, *Feltham 141* NU

DIPSACACEAE
Cephalaria
natalensis *Kuntze*, *Hilliard & Burtt 10123* NU
oblongifolia *(Kuntze) Szabo*, *Rennie 811* NU
Scabiosa columbaria *L.*, *Feltham 53* NU

CUCURBITACEAE
Mukia maderaspatana *(L.) M.Roem.*, *Rennie 1074* NU
Zehneria
parvifolia *(Cogn.) J.H.Ross*, *Rennie 793* NU
scabra *(L.f.) Sond.*, *Rennie 824* NU
Coccinia hirtella *Cogn.*, *Rennie 130* NU

CAMPANULACEAE
Wahlenbergia
appressifolia *Hilliard & B.L.Burtt*, *Rennie 331* NU
cuspidata *Brehmer*, *Rennie 818* NU
fasciculata *Brehmer*, *Rennie 18* NU
huttonii *(Sond.) Thulin*, *Rennie 1097* NU
krebsii *Cham.*, *Feltham 26* NU
pallidiflora *Hilliard & B.L.Burtt*, *Edwards 1081* NU
paucidentata *Schinz*, *Rennie 848* NU
rivularis *Diels*, *Rennie 393* NU
Craterocapsa tarsodes *Hilliard & B.L.Burtt*, *Rennie 497* NU

LOBELIACEAE
Cyphia
elata *Harv.*, *Rennie 526* NU
longifolia *N.E.Br.*, *Rennie 201* NU
natalensis *E.Phillips*, *Rennie 872* NU
rogersii *S. Moore* subsp. winteri *E.Wimm.*, *Edwards 1042* NU
tysonii *E.Phillips*, *Rennie 538* NU
Lobelia
flaccida *(C.Presl) A.DC.* subsp. flaccida, *Rennie 460* NU
erinus *L.*, *Feltham 34* NU
laxa *MacOwan*, *Rennie 871* NU
oreas *E.Wimm.*, *Rennie 83* NU
vanreenensis *(Kuntze) K.Schum.*, *Feltham 90* NU
Monopsis
decipiens *(Sond.) Thulin*, *Rennie 145* NU
stellarioides *(Presl) Urb.* subsp. stellarioides, *Rennie 966* NU

ASTERACEAE
Vernonia
flanaganii *(E.Phillips) Hilliard*, *Rennie 420*
gerrardii *Harv.*, *Rennie 339* NU
hirsuta *(DC.) Sch.Bip.*, *Hilliard & Burtt 7160* NU
natalensis *Sch.Bip. ex Walp.*, *Rennie 340* NU
neocorymbosa *Hilliard*, *Edwards 1988* NU
Aster
bakerianus *Burtt Davy ex C.A.Sm.*, *Feltham 120* NU
perfoliatus *Oliv.*, *Rennie 426* NU
pleiocephalus *(Harv.) Hutch.*, *Rennie 153* NU
Felicia
filifolia *(Vent.) Burtt Davy*, *Rennie 397* NU
linearis *N.E.Br.*, *Edwards 1048* NU
muricata *(Thunb.) Nees*, *Rennie 948* NU
rosulata *Yeo*, *Rennie 1857* NU
Nidorella
auriculata *DC.*, *Rennie 359* NU
undulata *(Thunb.) Sond. ex Harv.*, *Rennie 224* NU
Conyza
*bonariensis *(L.) Cronquist*, *Rennie 661* NU
*canadensis *(L.) Cronquist*, *Rennie 1130* NU
obscura *DC.*, *Rennie 563,*; *Edwards 2019* NU
pinnata *(L.f.) Kuntze*, *Rennie 209* NU
scabrida *DC.*, *Rennie 1398* NU
Nolletia rarifolia *(Turcz.) Steetz*, *Hilliard & Burtt 7163* NU
Chrysocoma ciliata *L.*, *Rennie 96* NU
Denekia capensis *Thunb.*, *Rennie 471* NU
Gnaphalium confine *Harv.*, *Rennie 649* NU
Troglophyton capillaceum *(Thunb.) Hilliard & B.L.Burtt* subsp. diffusum *(DC.) Hilliard*, *Rennie 1684* NU
Pseudognaphalium
luteo-album *(L.) Hilliard & B.L.Burtt*, *Rennie 220* NU
oligandrum *(DC.) Hilliard & B.L.Burtt*, *Hilliard & Burtt 7599* NU
undulatum *(L.) Hilliard & B.L.Burtt*, *Hilliard & Burtt 7593* NU
*Gamochaeta coarctata *(Willd.) Kerguélen*, *Rennie 992* NU [*Gnaphalium coarctatum* Willd.]
Helichrysum
acutatum *DC.*, Rennie 711 NU
adenocarpum *DC.*, *Rennie 747* NU
allioides *Less.*, *Edwards 2225* NU
appendiculatum *(L.f.) Less.*, *Feltham 258* NU
aureum *(Houtt.) Merr.*
var. aureum, *Rennie 127* NU
var. monocephalum *(DC.) Hilliard*, *Rennie 652* NU
var. serotinum *Hilliard*, *Rennie 525* NU
caespititium *(DC.) Harv.*, *Hilliard & Burtt 7175* NU
cephaloideum *DC.*, *Rennie 203* NU
chionosphaerum *DC.*, *Feltham 8* NU
confertifolium *Klatt*, *Rennie 1636* NU
cooperi *Harv.*, *A.P.D. McClean 208* PRE
dregeanum *Sond. & Harv.*, *Hilliard & Burtt 7211* NU
ecklonis *Sond.*, *Rennie 461* NU
epapposum *Bolus*, *Rennie 1687* NU
fulvum *N.E.Br.*, *Rennie 694* NU
glomeratum *Klatt*, *Scott-Shaw 3322* CPF
grandibracteatum *M.D.Hend.*, *Rennie 125* NU
herbaceum *(Andrews) Sweet*, *Rennie 308* NU
krebsianum *Less.*, *Rennie 205* NU
krookii *Moeser*, *Edwards 1075* NU
melanacme *DC.*, *Hilliard & Burtt 7592* NU
miconiifolium *DC.*, *Rennie 226* NU
monticola *Hilliard*, *Rennie 252* NU
mundtii *Harv.*, *Hilliard & Burtt 7590* NU
nudifolium *(L.) Less.*, *Rennie 868* NU
opacum *Klatt*, *Rennie 712* NU
oreophilum *Klatt*, *Rennie 338* NU
pallidum *DC.*, *Rennie 776* NU
pilosellum *(L.f.) Less.*, *Rennie 131* NU
platypterum *DC.*, *Rennie 373* NU
rugulosum *Less.*, *Rennie s.n.* NU
sessilioides *Hilliard*, *Rennie 175* NU
simillimum *DC.*, *Rennie 358* NU
spiralepis *Hilliard & B.L.Burtt*, *Rennie 990* NU
splendidum *(Thunb.) Less.*, *Rennie 204* NU
subluteum *Burtt Davy*, *Hilliard & Burtt 7190* NU
sutherlandii *Harv.*, *Rennie 374* NU
trilineatum *DC.*, *Rennie 1572* NU
umbraculigerum *Less.*, *Rennie 352* NU
vernum *Hilliard*, *Rennie 755* NU
Relhania acerosa *(DC.) Bremer*, *Rennie 93* NU
Macowania pinifolia *(N.E.Br.) Kroner*, *Rennie 407* NU [*Athrixia pinifolia* N.E.Br.]
Athrixia
angustissima *DC.*, *Rennie 303* NU
arachnoidea *J.M.Wood & M.S.Evans ex J.M.Wood*, *Rennie 405* NU
fontana *MacOwan*, *Rennie 239* NU
Printzia
auriculata *Harv.*, *Rennie 400* NU
pyrifolia *Less.*, *Rennie 355* NU
*Bidens pilosa *L.*, *Rennie 562* NU
*Galinsoga parviflora *Cav.*, *Rennie 544* NU
*Tagetes minuta *L.*, *Rennie 381* NU
Inulanthera coronopifolia *(Harv.) Källersjö*, *Rennie 380* NU
*Anthemis arvensis *L.*, *Rennie 218* NU
*Achillea millefolium *L.* s.l., *Rennie 865* NU
Lepidostephium asteroides *(Bolus & Schltr.) Kroner*, *Rennie 520* NU
Cotula
australis *(Spreng.) Hook.f.*, *Rennie 1143* NU
hispida *(DC.) Harv.*, *Rennie 1405* NU

Schistostephium
crataegifolium *(DC.) Fenzl ex Harv., Rennie 354* NU
hippiifolium *(DC.) Hutch., Rennie 398* NU
Artemisia afra *Jacq. ex Willd., Rennie 549* NU
Cineraria
deltoidea *Sond., Edwards 2015* NU
pinnata *O.Hoffm., Edwards 2034* NU
Senecio
adnatus *DC., Hilliard & Burtt 7615* NU
arabidifolius *O.Hoffm., Hilliard & Burtt 7212* NU
barbatus *DC., Hilliard & Burtt 7189* NU
brevidentatus *M.P.Hend., Hilliard & Burtt 7614* NU
bupleuroides *DC., Rennie 206* PRE
cathcartensis *O.Hoffm., Rennie 672* NU
citriceps *Hilliard & B.L.Burtt, Rennie 961* NU
coronatus *(Thunb.) Harv., Rennie 693* NU
deltoideus *Less., Rennie 5* NU
discodregianus *Hilliard & B.L.Burtt, Rennie 627* NU
dregeanus *DC., Rennie 986* NU
erubescens *Aiton*
var. crepidifolius *DC., Rennie 429* NU
var. erubescens *DC., Rennie 487* NU
glaberrimus *DC., Rennie 206* NU
gregatus *Hilliard, Rennie 1140* NU
harveianus *MacOwan, Rennie 353* NU
heliopsis *Hilliard & B.L.Burtt, Rennie 165* NU
hirsutilobus *Hilliard, Rennie 227* NU
hygrophilus *R.A.Dyer & C.A.Sm., Hilliard & Burtt 7530* NU
inaequidens *DC., Rennie 464* NU
inornatus *DC., Rennie 356* NU
isatideus *DC., Hilliard & Burtt 7616* NU
lydenbergensis *Hutch. & Burtt Davy, Rennie 987* NU
macrocephalus *DC. sens. lat., Feltham 191* NU
macrospermus *DC., Rennie 1369* NU
madagascariensis *Poir., Rennie 650* NU
marginalis *Hilliard, Rennie 472* NU
othonniflorus *DC., Hilliard & Burtt 7198* NU
oxyriifolius *DC., Rennie 1169* NU
panduriformis *Hilliard, Rennie 392* PRE
polyodon *DC.* var. polyodon, *Rennie 619* NU
retrorsus *DC., Hilliard & Burtt 7596* NU
ruwenzoriensis *S.Moore, Rennie 1054* NU
scitus *Hutch. & Burtt Davy, Hilliard & Burtt 7184* NU
striatifolius *DC., Hilliard & Burtt 7164* NU
subcoriaceus *Schltr., Rennie 603* NU
subrubriflorus *O.Hoffm., Rennie 347; Edwards 2018* NU
umgeniensis *Thell., Rennie 588* NU
Delairea odorata *Lem., Rennie 375* NU
Mikaniopsis cissampelina *(DC.) C.Jeffrey, Edwards 2047* NU
Euryops
evansii *Schltr., Edwards 1056* NU
laxus *(Harv.) Burtt Davy, Hilliard & Burtt 7165* NU
transvaalensis *Klatt, Rennie 309* NU
tysonii *E.Phillips, Rennie 527* NU
Othonna
burttii *B.Nord., Rennie 172* NU
natalensis *Sch.Bip., Rennie 1256* NU
Dimorphotheca
caulescens *Harv., Rennie 519* NU [*Osteospermum caulescens* Harv.]
jucundum *E.Phillips, Feltham 83* NU [*Osteospermum jucundum* (E.Phillips) Norl.]
Osteospermum attenuatum *Hilliard & B.L.Burtt, Rennie 307* NU
Chrysanthemoides monilifera *(L.) Norl., Edwards 2008* NU
Ursinia
montana *DC., Rennie 1846* NU
tenuiloba *DC., Rennie 279* NU
Arctotis arctotoides *(L.f.) O.Hoffm., Rennie 72* NU
Haplocarpha
nervosa *(Thunb.) P.Beauv., Rennie 601* NU
scaposa *Harv., Rennie 383* NU
Gazania linearis *(Thunb.) Druce, Feltham 143* a NU
Hirpicium armerioides *(DC.) Roessler, Rennie 467* NU
Berkheya
cirsiifolia *(DC.) Roessler, Rennie 1116* NU
debilis *MacOwan, Feltham 340* NU
macrocephala *J.M.Wood, Rennie 676* NU
rhapontica *(DC.) Hutch. & Burtt Davy*
subsp. platyptera *(Harv.) Roessler, Rennie 721* NU
subsp. rhapontica, *Rennie 570* NU
setifera *DC., Rennie 374* NU
speciosa *(DC.) O.Hoffm.* subsp. ovata *Roessler, Rennie 1168* NU
*Cirsium vulgare *(Savi) Ten., Rennie 571* NU
Dicoma anomala *Sond., Rennie 565* NU
Gerbera
ambigua *(Cass.) Sch.Bip., Hilliard & Burtt 7170* NU
piloselloides *(L.) Cass., Rennie 949* NU
Tolpis capensis *(L.) Sch.Bip., Rennie 851* a NU
Hypochoeris
*microcephala *(Sch.Bip.) Cabrera* var. albiflora *(Kuntze) Cabrera, Rennie 909* NU
*radicata *L., Rennie 854* NU
*Taraxacum hamatiforme *Dahlst., Rennie 605* NU
Sonchus
*asper *(L.) Hill, Rennie 703* NU
dregeanus *DC., Hilliard & Burtt 7191* NU
integrifolius *Harv., Rennie 701* NU
nanus *Sond. ex Harv., Rennie 5500* NU
*oleraceus *L., Rennie 823* NU
Lactuca
inermis *Forssk., Rennie 413* NU [*L. capensis* Thunb.]
tysonii *(E.Phillips) C.Jeffrey, Rennie 491* NU
Crepis hypochoeridea *(DC.) Thell., Rennie 859* NU

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Preliminary DNA fingerprinting of the turf grass *Cynodon dactylon* (Poaceae: Chloridoideae)

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Keywords: *Cynodon* Rich., genetic distances, identification, RAPDs, turf grasses

ABSTRACT

Identification of different cultivars of turf grasses is often very difficult. In a preliminary attempt to identify different cultivars of *Cynodon dactylon* (L.) Pers., random amplified polymorphic DNA (RAPD) analyses of some well-known cultivars used in South Africa, i.e. Bayview, Cape Royal, Florida, Harrismith, Silverton Blue, Skaapplaas and Tifdwarf, as well as 10 potential new cultivars, were done. These results were used to determine the genetic distances among cultivars. Only five primers were needed to obtain a specific fragment pattern for each cultivar. The degree of amplification was used as an additional criterion by including all visible fragments, excluding very faint fragments and only including the brightest fragments. The neighbour-joining trees of *C. dactylon* showed best resolution from the data set with all visible fragments included, although fragment intensity did not affect the tree topology. The cultivars Silverton Blue and Bayview exhibited the greatest genetic variation and two potential new cultivars were identified. RAPD analyses can, therefore, be used to distinguish between different *C. dactylon* cultivars and to determine the genetic variation between them by calculating genetic distances.

INTRODUCTION

The genus *Cynodon* Rich. comprises six species indigenous to South Africa: *C. bradleyi* Stent, *C. dactylon* (L.) Pers., *C. hirsutus* Stent, *C. incompletus* Nees, *C. polevansii* Stent and *C. transvaalensis* Burtt Davy, as well as two naturalized species, *C. aethiopicus* Clayton & Harlan and *C. nlemfuensis* Vanderyst (Gibbs Russell *et al.* 1990). These species are morphologically very similar. *Cynodon bradleyi*, *C. dactylon* and *C. transvaalensis* are cultivated as turf grasses. Often potential new cultivars are introduced, but are these really new cultivars or are some just variable morphological forms of existing cultivars?

In an attempt to find an easy, inexpensive and efficient method to distinguish between the different cultivars, and potential new cultivars, random amplified polymorphic DNA (RAPD) fingerprinting was used. Welsh & McClelland (1990), as well as Williams *et al.* (1990) first described this method. The technique has proven to be a powerful tool for investigating genetic variation in various plant groups (Williams *et al.* 1990; Carlson *et al.* 1991; Klein-Lankhorst *et al.* 1991; Michelmore *et al.* 1991; Welsh *et al.* 1991; Vierling & Nguyen 1992; Harada *et al.* 1993; Huff *et al.* 1993; Howell *et al.* 1994; Van Buren *et al.* 1994; Brummer *et al.* 1995; Hilu 1995; Multani & Lyon 1995; Wachira *et al.* 1995; Marillia & Scoles 1996; Bai *et al.* 1997; Parani *et al.* 1997; Swoboda & Bhalla 1997; Barker *et al.* 1999; Sun *et al.* 1999; Baranek *et al.* 2000; Gwanama *et al.* 2000; Lanteri *et al.* 2001).

RAPD analysis has also been widely applied to turfgrass and related grass profiling at molecular level. These include studies of perennial ryegrass (Sweeney & Danneberger 1994, 1997; Huff 1997); *Agrostis stolonifera* L. (Golembiewski *et al.* 1997); *Agrostis* spp. (Ohmura *et al.* 1997); *Poa pratensis* L. (Huff & Bara 1993; Barcaccia *et al.* 1997); *P. annua* L. (Sweeney & Danneberger 1995, 1996); as well as *Cynodon* (Busey *et al.* 1996).

Amplification conditions for RAPD analysis are similar to those used in a normal polymerase chain reaction, except that only one primer is used instead of two primers with specific sequences (Williams *et al.* 1990). As a result, amplification in RAPD analysis occurs everywhere in a genome, where it contains two complementary sequences to the primer that are within the length-limits of the polymerase chain reaction (PCR), which is ± 3 kb. The PCR patterns obtained from RAPDs are dependent on both the template and the specific PCR primer. Yu *et al.* (1993) observed the fragment size range to be from 0.5 to 2.5 kb and the fragment numbers from 1–10.

Polymorphisms detected by the RAPD technique are inherited as dominant markers in a Mendelian fashion and can be generated in any species without prior DNA sequence information (Williams *et al.* 1990; Welsh *et al.* 1991). Marsan *et al.* (1993) showed that DNA fragments, from inbred maize lines, were always present in one or both of the respective parental lines, thus suggesting that RAPD fragments were stably transmitted from generation to generation.

A general characteristic of the RAPD profile is the difference in fragment intensities. These differences in fragment intensities were therefore, also used as criteria in determining genetic variation within and between known cultivars and unknown specimens.

The aim of this preliminary study is to use DNA profiles generated by the RAPD method to identify various known *Cynodon* cultivars from vegetative material, and to identify potential new cultivars, by comparing them with some well-known cultivars currently used in the industry. A further purpose is to use the RAPD data to calculate the genetic distances between the different cul-

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tivars, thereby investigating the variation within and between the studied specimens.

MATERIALS AND METHODS

Plant material

Material from some of the most important commercially available cultivars were received from Top Crop Nursery and planted in a greenhouse at the Department of Plant Sciences: Genetics at the University of the Free State, under controlled environmental conditions. The plants were cultivated from vegetative material. Voucher herbarium specimens (Table 1) are housed in the Geo Potts Herbarium, University of the Free State, Bloemfontein (BLFU). The cultivars used were Bayview, Cape Royal, Florida, Harrismith, Silverton Blue, Skaapplaas and Tifdwarf, as well as 10 potential new cultivars (SAG.01–06 & 09–13).

TABLE 1.—Cultivar names and voucher numbers of *Cynodon dactylon* specimens

Cultivar*/code	Voucher no.
Cape Royal	*Spies 5821, 5822*
Tifdwarf	*Spies 5823, 5824*
Florida	*Spies 5825, 5826*
Bayview	*Spies 5827, 5828*
Silverton Blue	*Spies 5829, 5830*
Harrismith	*Spies 5831*
Skaapplaas	*Spies 5832*
SAG.01	*Spies 5833*
SAG.02	*Spies 5834*
SAG.03	*Spies 5835*
SAG.04	*Spies 5836*
SAG.05	*Spies 5837*
SAG.06	*Spies 5838*
SAG.09	*Spies 5840*
SAG.10	*Spies 5841*
SAG.11	*Spies 5842*
SAG.13	*Spies 5843*

*Duplicate samples of the first five cultivars were received, representing two different geographical areas. This was done to determine the variability within cultivars.

DNA extraction and RAPD amplification

DNA was extracted from ground leaves according to the method described by Edwards *et al.* (1991). The polymerase chain reaction (PCR) was carried out in a total volume of 25 µl, containing ± 25 ng of genomic DNA, 5–12pmol primer, 5 µl 5X Buffer [500 µl 10X Taq Polymerase buffer (500 mM potassium chloride, 100 mM Tris-HCl {pH 9.0}, 1% triton X-100), 1 mg gelatine, 2.25 µl triton X-100, 100 µl of each 100 mM deoxynucleotidephosphate, 457 µl sterilized water], 1.5 mM magnesium chloride and 1.25U of Taq polymerase. Five primers were used that showed clear reproducible banding patterns, i.e. OPA11 (5'-CAATCGCCGT-3'), OPA16 (5'-AGCCAGCGAA-3'), OPA20 (5'-GTTGCGATCC-3'), OPB03 (5'-CATCCCCCTG-3') and OPB06 (5'-TGCTCTGCCC-3') (Operon Technologies, Alameda, California). These primers were chosen because they provided excellent resolution with a large range of unrelated grasses in our laboratory (results not shown). Amplification cycles were as follows: initial denaturation at 94°C for 2 minutes, followed by 40 cycles of 30 seconds at 94°C, 30 seconds at 34°C and 90 seconds at 72°C with a final elongation step of 5 minutes at 72°C.

The reproducibility of the technique was tested by duplicating each reaction (44 reactions for 22 specimens per primer). This was done by performing amplifications on identical DNA samples in two different reactions. These findings confirmed that the fragment pattern for a particular combination of primer and DNA was reproducible for replicates, both in and between experiments.

Between 5–10 µl of the amplification product was mixed with gel loading buffer and separated on a 1% (m/v) agarose gel in TBE containing ethidium bromide (0.4 mg/ml). The gel was run in 0.3X TBE (1X TBE = 0.089 M Tris-HCl, 0.089 M boric acid, 0.002 M EDTA) or 0.5X TAE (1X TAE = 0.04 M Tris-HCl, 1.142 ml acetic acid, 0.001 M EDTA) buffer at 120 V for ± 60 minutes. DNA lambda molecular weight markers VI or X were included in each gel. The fragments were viewed under UV light and documented with a 35 mm photograph.

TABLE 2.—Comparison between five primers used with respect to no. of fragments observed, repeatability, fragment intensity and range of fragments

Primers	Fragments							
	Total no. scored	% without replication	% Faint	% Medium	% Bright	Min. no. per plant	Max. no. per plant	± Range of sizes (bp)
OPA-11	282	1.46	40.07	26.60	33.33	2	14	394–2300
OPA-16	374	2.82	49.73	25.67	24.60	4	15	394–2300
OPA-20	314	1.91	41.40	38.85	19.75	1	13	394–2300
OPB-03	302	1.33	40.07	28.80	31.13	3	10	350–2300
OPB-06	302	2.65	56.30	21.85	21.85	3	13	394–2176
Total/	1574	-	-	-	-	-	-	-
Average	-	2.03	45.52	28.35	26.13	2.6	13	-

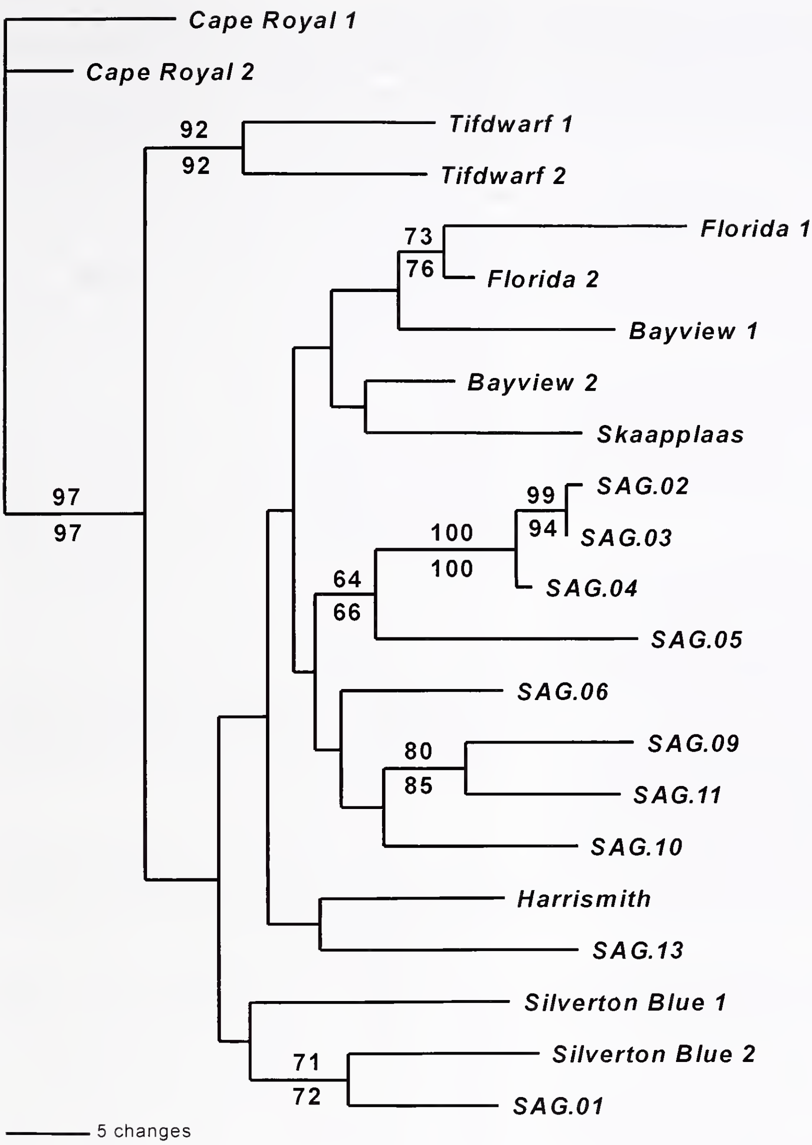

FIGURE 1.—Neighbour-joining tree constructed from the data matrix that included all visible RAPD fragments for *Cynodon*. Bootstrap values are indicated on branches and jackknife values below branches.

Fragment and phylogenetic analysis

The fragments were manually scored for each primer as present (1) or absent (0), for all the cultivars studied. Furthermore, the fragments were divided into three categories according to intensity of the fragments: bright, medium and faint fragments. The data were classified in three different sets, namely (a) including all visible fragments, (b) excluding faint fragments, and (c) using only bright fragments (Table 2).

The different fragment intensities observed with the amplification products were also scored, by comparing the fragments within a specific specimen, for each primer. This was done due to different specimens amplifying at different intensities.

The data were analysed with PAUP* (phylogenetic analysis using parsimony *and other methods) 4.0b8a (Swofford 1998). Cluster analysis was performed by using the neighbour-joining method (NJ) as implemented in this software and neighbour-joining trees were constructed, using total character difference as distance measure. Cape Royal was used as the outgroup in this study, being the morphologically distinct cultivar. Bootstrap values were calculated from 500 replicates (Felsenstein 1985) with resampling of all 96 characters. Jackknife values were calculated from 500 replicates, with 50% deletion and the emulate Jac resampling option in effect (Lanyon 1985).

RESULTS AND DISCUSSION

The 22 specimens of *C. dactylon* came from seven known cultivars, duplicate specimens (collected from different localities) of five of these cultivars and ten

potential new cultivars (Table 1). Table 2 contains information on the total number of fragments scored, the percentage of fragments that showed no replication, the percentage of faint, medium and bright fragments, the minimum and maximum number of fragments per specimen, and the range of fragment sizes.

For primer OPA11, Cape Royal 2 specimen and for primer OPA16, Cape Royal 1 and Silverton Blue 1, the duplicated reactions failed, as a result of total PCR failure (and thus not failure of repeatability). This information was not used in the calculations of the percentage of fragments that showed no repetition (Table 2).

The percentage of fragments, which showed no repetition in the duplicates of a reaction, varied from 1.33% in OPB03 to 2.82% in OPA16, with an average of 2.03% (Table 2). This indicates that fragment reproducibility was high with all the primers used, OPB03 being the most reproducible. Most of the fragments that showed no repetition were of faint intensity.

A series of tests, done on different DNA extractions from the same plant and different amplification of the same DNA sample, indicated that RAPD results are reliable. Well-amplified regions corresponded in all repeats from the same sample. The only differences observed were in faint fragments found in certain repeats.

A general characteristic of the RAPD profile is the difference in fragment intensities. Many speculations for the reason of this phenomenon have been given. One explanation is that the difference may be linked to the degree of homology between primer and template DNA (Thormann *et al.* 1994). Caetano-Anollés *et al.* (1991) speculated that it might be the result of amplification of multiple copies in the genome.

All five primers exhibited differences in the duplicate specimens of the cultivars Cape Royal, Tifdwarf, Florida, Bayview and Silverton Blue, which ranged from faint to bright fragment differences. These results indicate varying degrees of variability within these cultivars, especially Silverton Blue and Bayview. One fragment was consistent throughout all the specimens for two primers, namely a ± 700 bp fragment with primer OPA-16 and a ± 570 bp fragment with primer OPB-06. All the primers exhibited a few other prominent fragments in most of the specimens. Very few unique cultivar-specific fragments were found, which could be linked to the small sample size.

For the neighbour-joining analysis, the three different data sets for *Cynodon* (according to fragment intensity) were used separately. Though their intensities differ, the three data sets gave neighbour-joining trees with the same topology. The resolution decreased with fewer parameters (number of fragments), therefore, the neighbour-joining tree using all visible fragments was the best resolved and will be discussed further (Figure 1): SAG.01 groups with the Silverton Blue clade, with relatively high bootstrap and jackknife support. It is probably not a new cultivar, but a morphological variant of this cultivar. SAG.13 and Harrismith seem to follow the same pattern. There is, however, no substantial support for this grouping. Of the other potential new cultivars, SAG. 02–SAG.05 form a monophyletic clade and SAG.06 + SAG.09–SAG.11 form another monophyletic cluster. When comparing the fingerprinting patterns for the different specimens, the close affinities between specimens SAG.02, SAG.03, SAG.04 and SAG.05 (Figure 1; Table 2) were also evident. The groupings SAG.02–SAG.04 and SAG.09 + SAG.11 probably represent two potential new cultivars, with the variation within the clades being so small as to indicate that the specimens in each cluster are probably the same cultivar. These close affinities are corroborated by the bootstrap and jackknife support values within these groups, which are 100% and 80–85% respectively. The other members of these clades, SAG.05 and SAG.10 + SAG.06, are probably closely related variant forms. The distances within some of the existing cultivars are very large, which indicate large levels of genetic variation within these cultivars. This is especially true for the two cultivars Bayview and Silverton Blue. This is corroborated by the variability in fragment patterning observed in the different specimens for these cultivars. These results, in which these two cultivars are clearly non-monophyletic, might indicate that either the taxonomy of these cultivars are confused or the samples are in fact not purebred cultivars any more. The last possibility is very feasible in this group of grasses that constitute a heterogeneous group of varieties with considerable genotypic as well as phenotypic variation and in which outcrossing is frequent. The other duplicated cultivars form distinct groupings with high support bootstrap values for Cape Royal and Tifdwarf (97% and 92% respectively). Florida also exhibits some variability but not to the same extent as Silverton Blue and Bayview.

The number of specimens studied per cultivar was only two, due to the preliminary nature of the study. By increasing this number, the variability within cultivars can be investigated in more detail.

Very small genetic differences can be detected with RAPDs. In some cases these differences may include only a single DNA change. A single difference in the fragmenting patterns of different specimens does, therefore, not indicate separate cultivar status. It was, however, possible to distinguish between the different *Cynodon* cultivars with the RAPD fingerprinting patterns. More primers included and more samples per cultivar, would help to further resolve relationships, especially where the status of a cultivar is uncertain.

Although the reproducibility of this RAPD technique can be influenced by factors that may vary, such as template quantity and primer structure (Kernodle *et al.* 1993; Multani & Lyon 1995), the use of a standardized RAPD protocol and sufficient replication can ensure reproducible RAPD patterns (Multani & Lyon 1995). Furthermore, all reactions were always amplified simultaneously, and found to be repeatable across different amplification times.

These markers have the potential to be employed as genetic fingerprints for future identification.

CONCLUSIONS

This study indicated that different *Cynodon* cultivars differ genetically, and these variations can be determined by RAPDs.

The only two specimens with a similar fragmenting pattern, irrespective of the primer used, were SAG.03 and SAG.04. However, these specimens show similar patterns to SAG.02 and SAG.05 with most primers. This indicates that these four specimens are genetically very similar and could well be the same cultivar. This was reflected by the neighbour-joining analysis where SAG.02–SAG.05 and SAG.06 + SAG.09–SAG.11 form definite monophyletic groups with the clusters SAG.02–SAG.04 and SAG.09 + SAG.11, which appear to be new cultivars. This is supported by bootstrap and jackknife values and very little variance within these clusters. SAG.13 appears to be related to the Harrismith cultivar and SAG.01 to the Silverton Blue cultivar.

Furthermore, the variability within existing cultivars was very high in some instances, questioning their status as true cultivars. Due to the variable nature of the species it is very difficult to recognize the different cultivars of these turf grasses vegetatively, especially when they are frequently cut on lawns, bowling greens or golfing greens. This complicates the unequivocal identification of these cultivars.

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Miscellaneous notes

POACEAE

CHROMOSOME STUDIES ON AFRICAN PLANTS. 16. POLYPLOIDY IN THE GENUS *EHRHARTA*

The genus *Ehrharta* Thunb. comprises ± 36 species of which 20 are endemic to the winter rainfall area of South Africa (Verboom 2000). The genus belongs to the tribe Ehrharteae, which has been shuffled between the Phalarideae and the Oryzeae, the Ehrharteae and Arundineae of the Arundinoideae, the Ehrharteae of the Oryzoideae, and the Ehrharteae and the Oryzaneae of the Bambusoideae (Gibbs Russell & Ellis 1987). Recently the Ehrharteae was moved from the Arundinoideae (Renvoize 1981) to the Bambusoideae (Renvoize 1985; Watson *et al.* 1985). Linder & Ellis (1990) found no other representatives of the Bambusoideae present in the Fynbos Biome. Inclusion of the tribe Ehrharteae in the Bambusoideae rests on the presence of non-anatomical characters such as bambusoid embryos and lodicules (Renvoize 1985; Clayton & Renvoize 1986). Currently the Ehrharteae forms part of the ‘BEP’ clade (Bambusoideae, Ehrhartoideae and Pooideae) in grass phylogenetics (Clark *et al.* 1995).

The presence of many endemic species and the absence of any close relatives to *Ehrharta* in South Africa, may present us with some answers to the formation of polyploidy in grasses. Polyploidy is a common phenomenon among the grasses and Stebbins (1985) suggested that more than 80% of species in this family have undergone some form of polyploidy somewhere in their evolutionary history. In an attempt to determine the degree of polyploidy in South African grasses, our laboratory has studied chromosome numbers of various grasses and the results were mostly published in this series.

One of the genera that has been extensively studied, is the genus *Ehrharta*. Various chromosome number reports for the genus *Ehrharta* have been published (Avdulov 1931; Nakamori 1933; Parthasarathy 1939; Löve 1948; Stebbins 1949; Raven *et al.* 1965; Tateoka 1965; Fernandes & Queiros 1969; Stebbins 1985; Spies & Du Plessis 1986; Hoshino & Davidse 1988; Spies & Voges 1988; Spies *et al.* 1989). This report includes additional results from collections from 37 populations, representing nine different species or subspecies and includes first counts for three species and one subspecies. These new counts are combined with the published results (in total more than 100 specimens have been studied) in an attempt to determine the degree of polyploidy within this genus.

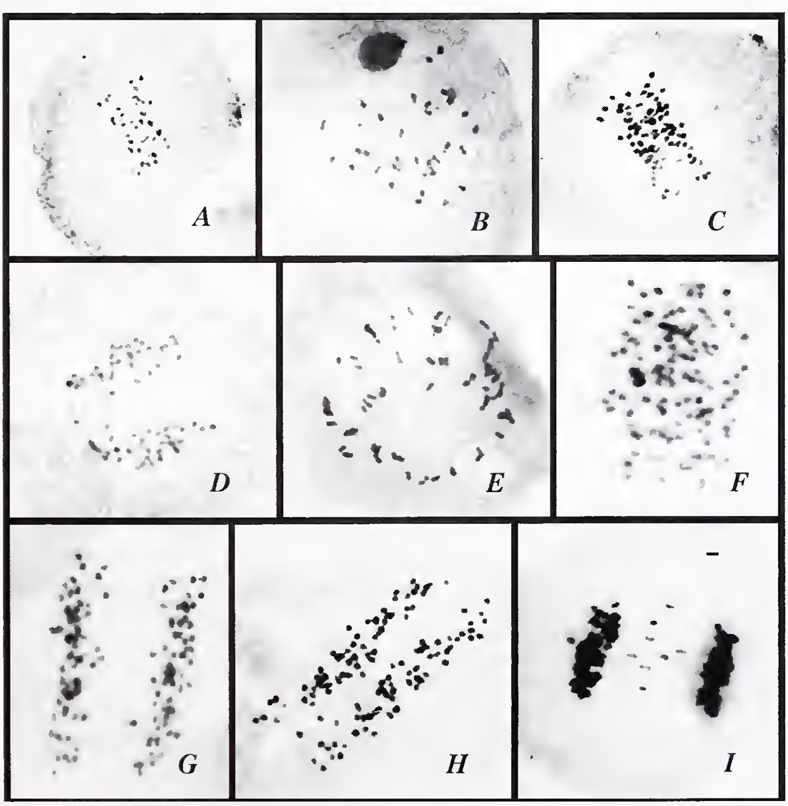

FIGURE 1.—Meiotic chromosomes in *Ehrharta*. A, *E. longifolia*, *Spies 6157*, 2n = 3x = 36, early anaphase I with a 15-21 segregation of chromosomes and even some chromatid segregation. B–D, *E. thunbergii*, *Spies 6031*, 2n = 6x = 72: B, diakinesis and early anaphase I with 36 chromosomes segregating towards each pole (not all chromosomes visible on the focus plane of photo). E–I, *E. villosa* subsp. *maxima*, *Spies 6193*, 2n = 8x = 96: E, diakinesis; F–H, early anaphase I, showing ± 48 chromosomes segregating towards each pole (a few cases of chromatid segregation can be observed and all chromosomes are not visible on this focus plane); I, late anaphase I, showing several laggards. Scale bar for A–I: 6.5 μm.

TABLE 1.—Gametic chromosome numbers of representatives of the genus *Ehrharta* (Poaceae) in southern Africa with their voucher specimen numbers and specific localities or a reference to the publication where the chromosome number was described. Species are listed alphabetically under the species groups of Gibbs Russell & Ellis (1987) and the localities are presented according to the system described by Edwards & Leistner (1971)

Taxon	n	Voucher no.	Locality or reference
Calycina Group			
E. brevifolia Schrad. var. *brevifolia*	12		Spies *et al.* (1989).
E. brevifolia Schrad. var. *cuspidata* Nees	12+0-1B		Spies *et al.* (1989).
E. calycina J.E.Sm.	12	*Spies 5937, 5938*	NORTHERN CAPE.—2917 (Springbok): 5 km from Kamieskroon to Leliehoek in the Kamiesberg Pass, (–DB).
		Spies 5950, 5952, 5953	NORTHERN CAPE.—2917 (Springbok): 8 km from Kamieskroon to Leliehoek on top of Kamiesberg Pass, (–DB).
		Spies 6043	NORTHERN CAPE.—3119 (Calvinia): 77 km from Clanwilliam to Nieuwoudtville, (–CB).
		Spies 5975	WESTERN CAPE.—3118 (Vanrhynsdorp): 8 km from Doring Bay to Lambert's Bay, (–CD).
		Spies 5977	WESTERN CAPE.—3118 (Vanrhynsdorp): 17 km from Doring Bay to Lambert's Bay, (–CD).
		Spies 6038	WESTERN CAPE.—3218 (Clanwilliam): 32 km from Clanwilliam to Nieuwoudtville, (–AA).
		Spies 5984	WESTERN CAPE.—3218 (Clanwilliam): 40 km from Clanwilliam to Lambert's Bay, (–BA).
		Spies 5990, 5995	WESTERN CAPE.—3218 (Clanwilliam): 10 km from Clanwilliam to Nieuwoudtville, (–CC).
		Spies 6013	WESTERN CAPE.—3218 (Clanwilliam): 14 km from Clanwilliam to Nieuwoudtville, (–CC).
		Spies 6260, 6261, 6262, 6265	WESTERN CAPE.—3218 (Clanwilliam): near Leipoldt's grave on top of Pakhuis Pass, (–CC).
		Spies 6082, 6322, 6323, 6326;	WESTERN CAPE.—3219 (Wuppertal): 6 km from Algeria to Citrus-dal on top of Nieuwoudt Pass, (–AC).
		Spies 6063, 6317	WESTERN CAPE.—3219 (Wuppertal): on top of Uitkyk Pass, (–AC).
		Spies 6253	WESTERN CAPE.—3318 (Cape Town): 3 km E from Mamre Road, (–BC).
		Spies 6211	WESTERN CAPE.—3420 (Bredasdorp): 1 km N of De Hoop Nature Reserve, (–BA).
		Spies 6156	EASTERN CAPE.—3323 (Willowmore): 13 km from Uniondale to Oudtshoorn, (–CA).
	12+0-2B		Löve (1948); Spies & Du Plessis (1986); Spies *et al.* (1989).
	24+0-2B		Parthasarathy (1939); Löve (1948); Spies & Voges (1988); Spies *et al.* (1989).
E. delicatula (Nees) Stapf	12		Spies *et al.* (1989).
E. longigluma C.E.Hubb.			Hoshino & Davidse (1988).
E. melicoides Thunb.	12		Spies *et al.* (1989).
E. pusilla Nees ex Trin.	12		Spies & Voges (1988); Spies *et al.* (1989).
Capensis Group			
E. barbinodus Nees ex Trin.	12	*Spies 6263*	NORTHERN CAPE.—3218 (Clanwilliam): near Leipoldt's grave on top of Pakhuis Pass, (–CC).
			Spies *et al.* (1989).
E. bulbosa J.E.Sm.			Uncounted.
E. capensis Thunb.	12		Spies *et al.* (1989).
E. eburnea Gibbs-Russ.			Uncounted.
E. longifolia Schrad.	12_{III}	*Spies 6157*	EASTERN CAPE.—3323 (Willowmore): 5 km from Uniondale to Oudtshoorn, (–CA).
E. ottonis Kunth ex Nees			Uncounted.
Dura Group			
E. dura Nees ex Trin.	12+0-4B		Spies *et al.* (1989).
E. microlaena Nees ex Trin.			Uncounted.
Erecta Group			
E. erecta Lam. var. *abyssinica* (Hochst.) Pilg.	12		Tateoka (1965).
E. erecta Lam. var. *erecta*	12		Avdulov (1931); Parthasarathy (1939); Stebbins (1949); Raven *et al.* (1965); Fernandes & Queiros (1969); Stebbins (1985); Spies & Du Plessis (1986); Hoshino & Davidse (1988); Spies *et al.* (1989).
	24		Nakamori (1933); Stebbins (1949, 1985); Spies & Du Plessis (1986).
E. erecta Lam. var. *natalensis* Stapf	12		Spies *et al.* (1989).
E. longiflora J.E.Sm.	12	*Spies 6325*	WESTERN CAPE.—3219 (Wuppertal): on top of Nieuwoudts Pass, (–AC).
	12		Spies *et al.* (1989).
	24		Parthasarathy (1939); Spies *et al.* (1989).
E. triandra Nees ex Trin.	12		Spies *et al.* (1989).
	24		Spies *et al.* (1989).
Ramosa Group			
E. ramosa (Thunb.) Thunb. subsp. *aphylla* (Schrad.) Gibbs-Russ.	12	*Spies 6319*	WESTERN CAPE.—3219 (Wuppertal): on top of Uitkyk Pass, (–AC).
		Spies 6167, 6168	WESTERN CAPE.—3322 (Oudtshoorn): Swartberg Pass, (–AC).
		Spies 6233	WESTERN CAPE.—3419 (Caledon): Galgeberg, (–BA).

TABLE 1.—Gametic chromosome numbers of representatives of the genus *Ehrharta* (Poaceae) in southern Africa with their voucher specimen numbers and specific localities or a reference to the publication where the chromosome number was described. Species are listed alphabetically under the species groups of Gibbs Russell & Ellis (1987) and the localities are presented according to the system described by Edwards & Leistner (1971) (continued)

Taxon	n	Voucher no.	Locality or reference
E. ramosa subsp. *ramosa*	12 12	*Spies 6180*	WESTERN CAPE.—3322 (Oudtshoorn): Robinson's Pass, (–CC). Spies *et al.* (1989).
E. rehmannii Stapf subsp. *filiformis* (Stapf) Gibbs-Russ.			Uncounted.
E. rehmannii subsp. *rehmannii*	12 12+0-5B	*Spies 6161*	WESTERN CAPE.—3322 (Oudtshoorn): Montagu Pass, (–CD). Spies *et al.* (1989).
E. rehmannii subsp. *subspicata* (Stapf) Gibbs-Russ.	36		Spies *et al.* (1989).
Setacea Group			
E. rupestris Nees ex Trin. subsp. *dodii* (Stapf) Gibbs-Russ.			Uncounted.
E. rupestris subsp. *rupestris*			Uncounted.
E. rupestris subsp. *tricostata* (Stapf) Gibbs-Russ.			Uncounted.
E. setacea Nees subsp. *disticha* Gibbs-Russ.			Uncounted.
E. setacea subsp. *scabra* (Stapf) Gibbs-Russ.			Uncounted.
E. setacea subsp. *setacea*			Uncounted.
E. setacea subsp. *uniflora* (Burch. ex Stapf) Gibbs-Russ.			Uncounted.
Villosa Group			
E. thunbergii Gibbs-Russ.	36	*Spies 6031*	WESTERN CAPE.—3218 (Clanwilliam): 22 km from Clanwilliam to Nieuwoudtville, (–CB).
E. villosa Schult. f. var. *maxima* Stapf	48	*Spies 6193*	WESTERN CAPE.—3420 (Bredasdorp): Waenhuiskrans, (–CA).
E. villosa var. *villosa* Stapf	60		Spies *et al.* (1989).

MATERIALS AND METHODS

For this study, cytogenetic material of identical plants of a population was collected and fixed in the field. Voucher specimens listed in Table 1 are housed in the Geo Potts Herbarium, Department of Botany and Genetics, University of the Orange Free State, Bloemfontein (BLFU). The National Herbarium, Pretoria, identified the plants.

Anthers were squashed in aceto-carmine and meiotically analysed (Spies *et al.* 1996). Gametic chromosome numbers are presented for meiotic chromosomes to conform to previous work on chromosome numbers (Spies & Du Plessis 1986). Previously published somatic chromosome numbers are transformed to gametic numbers for convenience.

RESULTS AND DISCUSSION

Thirty-seven populations, representing nine species or subspecies, were studied (Table 1). All numbers support a basic chromosome number of 12 (Stebbins 1949; Spies *et al.* 1989). The majority of populations studied (93.6%) were diploid ($2n = 2x = 24$), with one triploid specimen, *E. longifolia*: $2n = 3x = 36$ (Figure 1A); one hexaploid, *E. thunbergii*: $2n = 6x = 72$ (Figure 1B–D); and one octoploid, *E. villosa* var. *maxima*: $2n = 8x = 96$ (Figure 1E–I). *Ehrharta longifolia* is, to the best of our knowledge, the first triploid *Ehrharta* sample ever observed. Meiosis in this specimen was usually abnormal with numerous univalents, chromatid segregation during anaphase I, chromosome/chromatid laggards and micronuclei present. This is unfortunately the first chromosome count for this species and more individuals from more populations of this species should be investigated to determine the real chromosome number of this species.

In addition to our count for *E. longifolia*, we also report the first counts for *E. ramosa* subsp. *aphylla* ($2n = 2x = 24$), *E. thunbergii* ($2n = 6x = 72$) and *E. villosa* var. *maxima* ($2n = 8x = 96$). When all chromosome numbers are compared, two interesting phenomena emerge. There are no counts for any member of the Setacea Group (in spite of numerous collections by our laboratory, no successful preparations were made) and all three counts for the Villosa Group are polyploids. Additional populations should be studied to determine whether this whole group consists of high ploidy levels and whether it represents hybrids (alloploids) between representatives of other groups.

The majority of populations studied (more than 97%) suggest a basic chromosome number of $x = 12$ for *Ehrharta*. However, basic chromosome numbers higher than nine are secondarily derived basic numbers (Goldblatt 1980). It is also well known that most bambusoids have a secondary basic chromosome number of 12 (Stebbins 1985). Stebbins (1985) suggested that polyploidy follows one of four different ways in grasses. *Ehrharta* forms part of Stebbins' third mode of polyploidy—'multiples of a basic number that is the lowest in its genus, but was probably derived from that of pre-existing genera by a cycle of polyploidy in the remote past'. An example of this mode is given as *Leersia* Sw., another member of the Bambusoideae (Stebbins 1985). The genus *Ehrharta* is consequently of ancient polyploid origin and the basic chromosome number of $x = 12$ can be described as a secondary basic chromosome number.

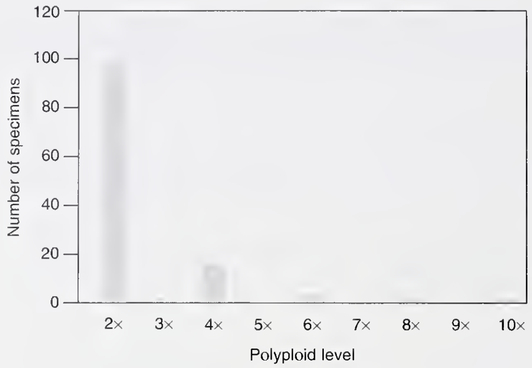

FIGURE 2.—Number of specimens per ploidy level for all *Ehrharta* specimens studied.

This paper began by mentioning that more than 80% of grasses are polyploids; the question remains whether the initial polyploidization of the basic chromosome number in *Ehrharta* enhanced or inhibited further polyploidization events. All chromosome numbers observed for *Ehrharta* populations indicate that 82.8% are 'diploid' (Figure 2). This dramatic decrease from 80% polyploidy in grasses to more than 80% diploidy in *Ehrharta* indicates that the initial polyploidization event probably inhibited the consequent formation of polyploidy in the genus. However, the frequency of polyploidy varies in different taxa and this conclusion should be studied further in order to determine whether the decrease in secondary polyploidization is a general phenomenon or specific to the genus *Ehrharta.* The influence of climatic and geographical factors on polyploidization is not fully understood, therefore, we did not compare these results with chromosome numbers of other bambusoids, since no other bambusoids grow sympatrically with *Ehrharta.*

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OBITUARY

ANNA AMELIA OBERMEYER-MAUVE (1907–2001)

Anna Amelia Obermeyer (Figure 1) was born in Pretoria on 30 July 1907. She matriculated (completed her schooling) at Oost Eind School, Pretoria, in 1925, and then attended the Transvaal University College (now Pretoria University), obtaining the degrees of B.Sc. in 1928 and M.Sc. in 1931. In May 1929 she was appointed botanist in the Transvaal Museum, a post she held until August 1938, when she married Mr Anton Mauve (a collateral descendant of the artist Vincent van Gogh). Before World War II and for many years afterwards, marriage meant exchanging a paid professional career for that of a housewife, and this Mrs Mauve did until 1 December 1957, when she joined the staff of the National Herbarium. In effect, she returned to her former post, as the botanical collections of the Transvaal Museum were transferred to the National Herbarium in 1953 (Fourie 1998) (Figure 2). This time, she was placed in charge of the petaloid monocots, and remained until she reached pensionable age on 30 July 1972. After an overseas holiday with her husband, she returned in a temporary capacity on 30 October 1972. 'Temporary' in this instance acquired an air of permanence, and she was promoted to Temporary Senior Agricultural Researcher on 1 April 1984. She finally retired on 31 August 1985, moved to Pinelands (Cape Town), and passed away peacefully on 10 October 2001.

She studied under Professor C.E.B. Bremekamp at the University of Pretoria, and so was well trained to undertake taxonomic research. At the Transvaal Museum she put this training to good use, and worked mainly on Acanthaceae, producing revisions of *Barleria, Blepharis* and *Petalidium*. In addition, she wrote up large collections of plants from the Vernay-Lang expedition to the Kalahari and by Herbert Lang in the Kruger National Park. These were among the first accounts of the flora of these regions. She participated with Prof. Schweickerdt and Miss Verdoorn in an expedition to the Soutpansberg Salt Pan, and was senior author of the resultant published account of specimens collected.

On her return to botany in 1957, she commenced work on the petaloid monocots. The bulk of her publications list from this period is made up of descriptions of individual new species, texts for plates published in *Flowering Plants of Africa* and brief nomenclatural notes. However, she also completed revisions of *Anthericum* and its immediate allies, *Dipcadi* and *Lagarosiphon*. Her service at the Botanical Research Institute coincided with the most active period of production of the *Flora of southern Africa*, and it was stated in the citation for her award of the South African Association of Botanists (SAAB) senior medal for botany, that she had made more contributions to that project than any other botanist. This record still stands, and will probably continue to do so, as National Botanical Institute priorities are now elsewhere, and *Flora* accounts are sought from a much wider pool of botanists than was the case forty years ago.

Where possible, Mrs Mauve made a point of seeing the plants she described in the field. In the course of field expeditions ranging from the massive one to the Soutpansberg, down to brief trips of a few hours, she collected some 4 000 specimens. She collected not only in South Africa, but also on a pioneering expedition to the Eastern Highlands of Rhodesia (now Mutare and Chipinge Districts of Zimbabwe) with Dr V. FitzSimons in 1937. Her specimens are housed in PRE, with duplicates sent to other herbaria as part of the PRE exchange programme and so almost impossible to trace.

For many years she was a member of the council of the South African Biological Society, and edited their journal for part of that time. She was a foundation member of SAAB, and a member of AETFAT (Association pour l'Étude Taxonomique de la Flore d'Afrique Tropicale) and S_2A_3 (the South African Association for the Advancement of Science), whose meetings served the function of bringing botanists together before SAAB was founded.

De Winter & Killick (1982) described her in their motivation for the SAAB award as "one of those self-effacing but completely dedicated 'backroom girls' of science". This fits well with the memories of those who

FIGURE 1.—Anna Amelia Mauve, née Obermeyer (1907–2001). Photo: NBI archive.

FIGURE 2.—From left to right: Mrs Mauve, Dr E.P. Phillips, Mrs R. Pott-Leendertz, Miss I.C. Verdoorn, at the ceremony for the presentation of the Transvaal Museum Herbarium to the National Herbarium, 10 September 1953. Photo: NBI archive.

had the privilege of meeting her in the old Botanical Research Institute. Her knowledge of the petaloid monocots was encyclopaedic, and she shared it with the young freely, but in a very kindly way. The motivation referred to above also mentions the many thousands of identifications she did for other scientists, and her curatorial activities. Indeed, twenty years after that motivation was written, her curation of the monocot specimens is still much in evidence. Although most of this evidence is positive, it has to be admitted that some features of late-twentieth century taxonomic practice passed her by. For example, she apparently never understood the full implications of the idea that PRECIS records of re-identified specimens needed to be updated before the specimens were re-filed. Even today it is not unknown to find an irate member of curatorial staff in the monocots, annoyed at having unearthed yet another 'lost' specimen that was simply re-filed under a new name by Mrs Mauve, who had not informed the computer. However, she was, until the day she finally left the Institute, 'generous to a fault with assistance rendered to all who have approached her', to quote again from De Winter and Killick's motivation.

Volume 42 of *The Flowering Plants of Africa* (1970–1972) was dedicated to her. In 1983 she was awarded the SAAB Senior Medal for Botany. Part 6 of volume 53 of *South African Journal of Botany* bears a dedication to Mrs Mauve, and is made up chiefly of papers on groups in which she was interested.

Mrs Mauve is commemorated in the plant names *Hemizygia obermeyerae* Ashby, *Asparagus obermeyerae* Jessop, *Barleria ameliae* A.Meeuse and *Lachenalia ameliae* W.F.Barker.

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Book Review

BIODIVERSITY RESEARCH IN THE HORN OF AFRICA REGION—PROCEEDINGS OF THE THIRD INTERNATIONAL SYMPOSIUM ON THE FLORA OF ETHIOPIA AND ERITREA AT THE CARLBERG ACADEMY, COPENHAGEN, AUGUST 25–27, 1999, edited by IB FRIIS & OLOF RYDING. 2001. *The Royal Danish Academy of Sciences and Letters*, Copenhagen, in KDVS Biologiske Skrifter 54. Available from C.A. Reitzel A/S, Nørregade 20, DK-1165 Copenhagen K, Denmark. Soft cover ISSN 0366-3612, ISBN 87-7876-246-4, price 500 DKK/US$ 60 (excluding P+P).

When I received the request to review this publication, I must admit I dreaded the idea. Let me explain. First, it is a rather hefty publication —intimidating even enthusiasts like myself. Secondly, proceedings are generally bland, and as one of the editors of the publication wrote in his correspondence to the editor of *Bothalia* 'proceedings are difficult to review'. Thirdly, even though once upon a time I was a taxonomist and actually did enjoy my research work, I have not practised as a researcher for six years. Instead, the last six years have seen me involved in and shaping global and national policy issues. I therefore did not think this would interest me. I will not bore you with the details of how I overcame my dread; the most important thing is that you are now reading this review!

Let me first make some general comments. After spending a couple of days going through the 439-page publication, I have to say something to all those who participated in the Ethiopian Flora Project. Well done!

One of the aspects I liked about this publication was that even though I had little background about the project and certainly did not read the proceedings of the first and the second symposia, the introductory section of the publication put me in the picture and gave context to the rest of the papers in the publication. The introductory section is quite interesting to read—it touches on the history of the project which was launched in 1980, but the idea dates back to 1967. It also gives the reader an insight into the political situation and conflict between Ethiopia and Eritrea, which certainly had an impact on the project.

I was quite impressed by the collaborative effort between the 35 European, Ethiopian, Arabian and American scientists as evidenced by authors of the 26 papers presented. The resulting capacity building from the project is commendable: several Ethiopian scientists have been trained as part of the project, the capacity of the National Herbarium in Addis Ababa has been enlarged, the number of herbarium specimens increased from 16 000 to 70 000! All these details are contained in the introductory part of the publication.

The remainder of the publication contains several scientific papers covering a range of disciplines. I actually took time to read some of the papers dealing with taxonomy and systematics. I think the research findings presented in these papers make a significant contribution to the knowledge and documentation of Africa's floral diversity. Then there are papers on the history of scientific study of Ethiopian and Eritrean flora as well as an account of some of the early explorations in that part of the world. The publication also contains papers describing the diversity, endemism, patterns of distribution of flora of not just Ethiopia and Eritrea, but also of northeast tropical Africa (Eritrea, Ethiopia, Djibouti, Somalia, Kenya). As part of this set of papers, there is an account of avian endemism in northeastern tropical Africa and which is co-authored by a South African.

I did anticipate that proceedings would address ethnobotany. I have gathered from global meetings attended, that Ethiopia attaches importance to and strongly promotes conservation and sustainable use of its genetic resources, particularly in the context of agriculture. The three papers on ethnobotany were interesting to read. The links between Ethiopia's floral diversity and agriculture, forestry and cultural heritage are well illustrated in these papers. The final part of the publication deals with vegetation. There are five papers on this topic, including a paper on the review of the existing vegetation map of Ethiopia and Eritrea which points out the need for a new map.

Most of the papers presented in the publication contain either illustrations, drawings, diagrams, maps and photographs. I think the downpoint of the publication is that most of these are in black-and-white, with only a few colour photographs.

As you might have noted, the publication should be of interest to mainly the research fraternity. South African botanists, particularly those who collaborate across the African region should find it a valuable resource.

As I went through it I could not help but think of how relevant this project is to Article 7a of the Convention on Biological Diversity (CBD) and Global Taxonomy Initiative (GTI). The GTI African Regional Workshop held at the Kirstenbosch National Botanical Gardens from 27th February to 1st March 2001, adopted the Kirstenbosch Declaration which recommended, among others of relevance to the work presented in this publication that:'Parties support existing African national and regional networks that promote implementation of the GTI, for example SABONET, AETFAT, BOZONET, and WAFRINET, SAFRINET, and EAFRINET of BioNET-INTERNATIONAL' (Klopper *et al.* 2001). The work presented in this publication lays a solid foundation for, and makes good contribution towards the implementation of the GTI and other similar initiatives.

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